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USE OF AN OPTICAL PROBE TO MEASURE BUBBLE CHARACTERISTICS IN GAS FLUIDIZED BEDS

BY
THOMAS T. CHU

A DISSERTATION
SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL
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APPROVAL OF DISSERTATION

BUBBLE CHARACTERISTICS IN GAS FLUIDIZED BEDS

BY

THOMAS T. CHU

FOR

DOCTOR OF ENGINEERING SCIENCE

1984

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ABSTRACT

A novel optical probe has been developed and used for on-line monitoring of the bubble characteristics in a three-dimensional gas fluidized bed. The probe sensor has a major dimension of 1.8 cm, and contains an LED and a photo-cell separated by a gap of 2.5 mm. Coupled with a non-inverting comparator circuit with hysteresis as a noise filter, the probe has been very effective in characterizing the size distribution, shape and velocity of gas bubbles.

A 96 liter rectangular fluidized bed was used, containing glass beads with a size fraction of 355μ to 250μ. Air was the fluidizing medium, with gas velocities ranging from 1.2 U_{mf} to 2 U_{mf}. The probe position was varied from 35 to 55 cm above the distributor, and 0 to 8 cm from the bed centerline. The bubble size distribution was fit to a truncated gamma function. It was also found that the Davies-Taylor Equation for bubble velocity was inadequate to fit the data, since the velocity varied significantly with the position in the bed.

Motion pictures were also taken in a two-dimensional bed to obtain qualitative information on bubble characteristics.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure		Page

NOMENCLATURE

Symbol	Definition
A_L	Bubble Central Vertical Axial Length (cm)
D_B	Superficial Bubble Diameter (cm)
D_E	Bubble Spherical Equivalent Diameter (cm)
d	Distance Between Sensors on Probe Vertical Axis (cm)
d_e	Truncated Bubble Spherical Equivalent Diameter (cm)
$\bar{d}_e$	Mean of Bubble Size Distribution Function
d_r	Distance Between Sensors on Probe Transverse Axis (cm)
F_D	Distance to Bubble Frontal Surface at Radial Distance d_r (cm)
H	Height of Indentation (cm)
H_W	Height of Wake (cm)
k	Parabolic Constant
L_2	Bubble Vertical Chord Length at Radial Distance d_r (cm)
R_B	Superficial Bubble Radius (cm)
R_F	Radius of Curvature of Bubble Frontal Surface (cm)
R_W	Radius of Curvature of Bubble Wake Surface (cm)
r	Radius of Bubble Base (cm)
T_1	Pulse #1 Duration Time (Number of Time Intervals)
T_2	Pulse #2 Duration Time (Number of Time Intervals)

Symbol	Definition
T_3	Pulse #3 Duration Time (Number of Time Intervals)
T_4	Pulse #4 Duration Time (Number of Time Intervals)
T_{D1}	Delay Time Between Pulse #2 and Pulse #4 (Number of Time Intervals)
T_{D2}	Delay Time Between Pulse #2 and Pulse #3 (Number of Time Intervals)
t	Time (sec)
U_B	Bubble Velocity (cm/sec)
$\overline{U}_B$	Mean Bubble Velocity (cm/sec)
U_g	Superficial Gas Velocity (cm/sec)
U_{mf}	Minimum Fluidization Velocity (cm/sec)
V_B	Bubble Volume (cm^3)
V	Signal Voltage (volt)
V_H	Signal Voltage at High
V_L	Signal Voltage at Low
V_R	Reference Voltage of Comparator
Z_v	Vertical Distance Above Gas Distributor (cm)
Z_l	Lateral Distance From Bed Centerline (cm)
$\Gamma(x)$	Gamma Function of x
α	Scale Parameter of Gamma Function Distribution
β	Shape Parameter of Gamma Function Distribution
δ	Truncate Error (cm)
σ^2_{de}	Variance of Bubble Size Distribution

Symbol	Definition
	Standard Deviation of Mean Bubble Velocity
R_a	Adjustable Attenuator Resistance
R_b	Bias Resistance
R_f	Feed Back Resistance
R_i	Input Resistance
R_{ref}	Adjustable Reference Resistance
V_{H1}	High Limit of Hysteresis Window Width
V_{H2}	Low Limit of Hysteresis Window Width
V_i	Input Voltage Before Attenuator
V_i'	Input Voltage After Attenuator
V_i''	Feed Back Voltage
V_{ref}	Reference Voltage

Chapter I

INTRODUCTION

The beginning of the fluidized bed can be traced back to the Winkler gas generator nearly sixty years ago. It is the first patented large-scale fluidized-bed coal gasifier[1] although the nomenclature is hardly recognizable. At present there is a tremendous amount of literature covering the fluidization theory, bubble phenomena and heat and mass transfer. It has not only been applied to chemical and petroleum industiries but also has found application in energy and environmental industries, and in many other fields requiring various solid-handling techniques.

In spite of this long history, the enormous research and development effort and extensive application of fluidization technique, many fluidized beds have been rather less than successful. Only in the last few years have some of the reasons for earlier failures become apparent with one of the most common causes being the lack of complete understanding of the complex hydrodynamics of solids and fluids within the fluidized beds.

Almost all gas solid fluidized beds operate with bubbles in the bed. Only under one circumstance, the ratio of bed solid density to fluidizing medium density is less than about 10, there will be no bubble appearance[2]. The position, size, shape and velocity of bubbles in the bed determine how both solid and gas will move. The bubbles also determine the heat transfer properties at the walls and gas-solid exchange coefficients. Thus the design of a gas fluidized bed for most industrial purposes requires the knowledge of the bubble characteristics, although the bubble cannot normally be seen deep in the interior.

The first appearance of gas in a fluidized bed is not in the form of bubbles, but in the form of jets as shown in Figure 1. Then, bubbles erupt from the jets formed at the distributor which supports the fluidized bed. In the study of fluidized bed characteristics, the region near the distributor called the distributor-region or grid-region is sometimes treated separately from the higher position of the bed called bubble-region, since these two regions have distinct differences in characteristics in many respects[3]. For example, bubbles are rather uniform in size at the grid-region and as they rise higher along the bed the size variation becomes greater. Since bubble size in the grid-region is much smaller than the size higher up in the bed, gas exchange between bubble phase and emulsion phase is vigorous, resulting in a high gas-solid contact efficiency.

Various methods have been adopted by investigators for measuring the bubble size, shape, frequency and velocity

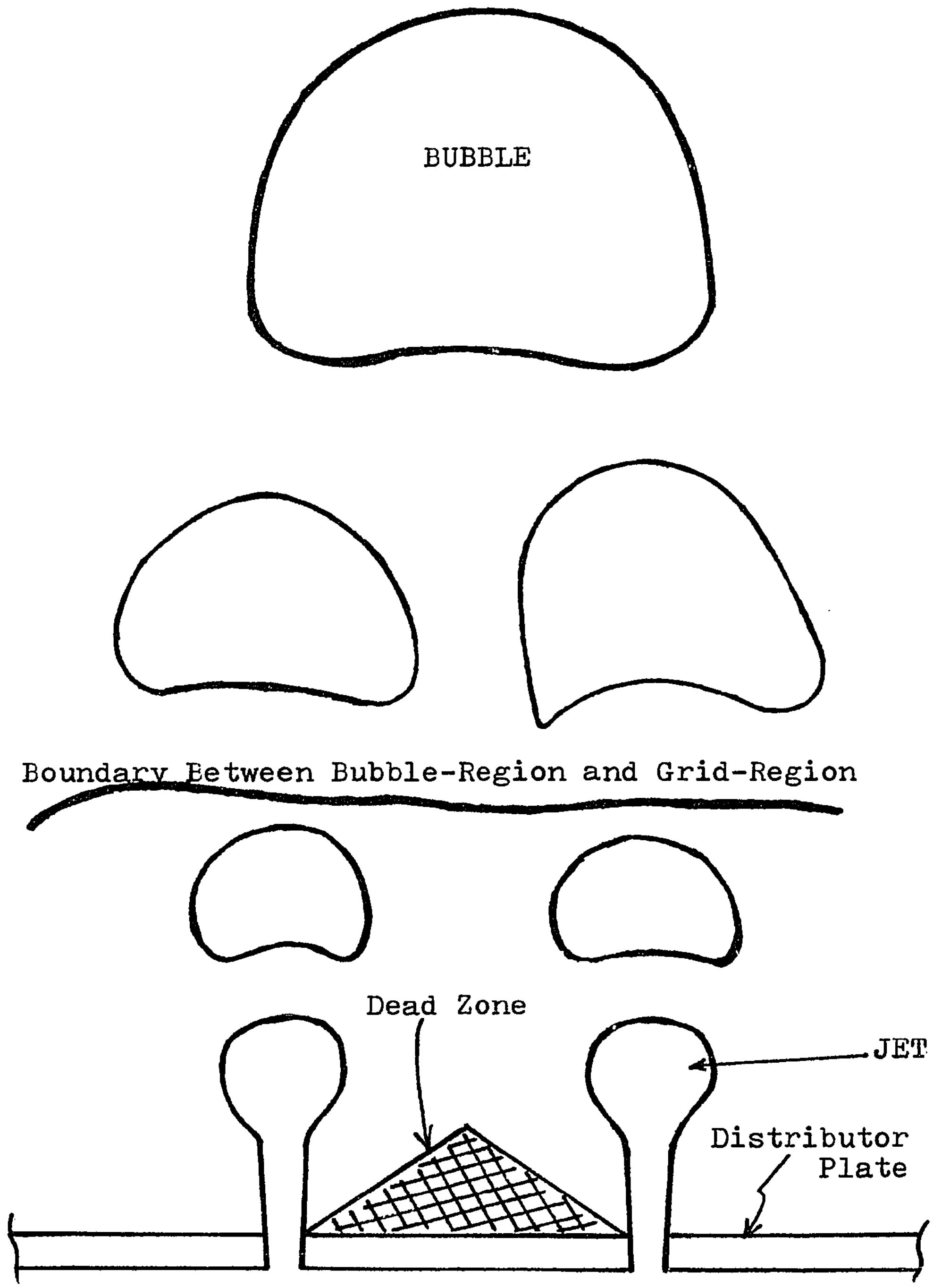

Figure 1. Schematic representation of the bulk gas-flow pattern in bubble-region and grid-region of fluidized beds.

in the bubble region of fluidized beds. Practically all of the methods for bubble characteristics measurement in fluidized beds have fallen into one of the following categories:

(a) Photography

(b) X-ray and γ-ray techniques

(c) The use of probes.

Photography is essentially limited to two-dimensional (2-D) beds in which the bubbles span the thickness of the beds and are therefore clearly visible[4,5,6,7]. Figure 2, a photograph of a 2-D bubble, shows the size and shape of the bubble. When studying three-dimensional (3-D) beds photographic methods are severely limited. Another limitation is the shape of a two-dimensional bubble may not be the same as a three-dimensional bubble under the same bed operating conditions.

X-ray cine photography probably gives the most direct and unambiguous information of actual bubble characteristics. Some successful observations have been made of the behavior of the bubbles in the interior of 3-D beds by the use of X-ray photography[8,9,10]. A method based upon the absorption of γ-rays has also been used[11,12]. However, the use of both X-rays and γ-rays involves complex equipment and shielding and are confined to relatively small beds under laboratory conditions. A large bed would have resulted in an extremely long detection path for external X- and γ-ray

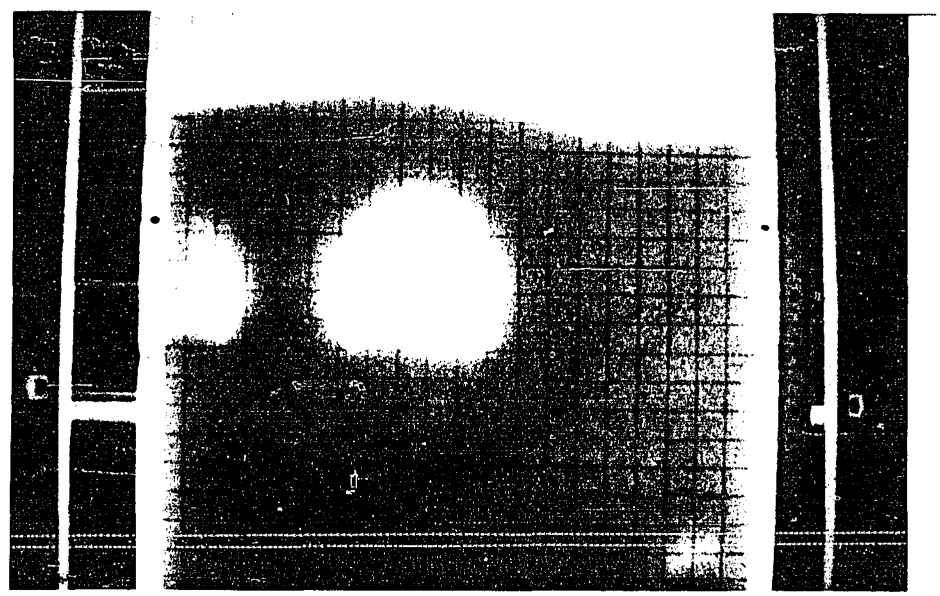

Figure 2. A photograph of a two-dimensional bubble.

techniques and absorption probably would have been too high. Under certain circumstances the number of overlapping bubbles in such a bed could also be unacceptably large.

For large beds and those operating under industrial conditions the only practical means of observation is by probes. Thus, the most popular technique for the study of the bubble is probably the probing technique.

There are four kinds of probes usually used to study bubble characteristics in gas fluidized beds, namely, (a) conductance probe, (b) inductance probe, (c) capacitance probe, and (d) optical probe. The signals they generate can be processed and interpreted in a variety of ways but they also have their own limitations. A common uncertainty exists in these probes in deciding the bubble size and velocity distribution at a point in the bed due to the unpredictable positions at which the probe contacts the bubble frontal surfaces.

In general, conductance probes are limited in their applicability to liquids and relatively more conductive solids. Fluidized coke particles conduct electricity well thus allowing electrical resistivity to be used to indicate the presence of bubbles in a fluidized coke bed[13,14,15,16].

Capacitance probes have been used by more investigators than the other kinds, presumably because they work well with nonconducting materials such as sand and glass beads which are commonly used in laboratory fluidized beds. However, capacitance probes have four major disadvantages. The wires that are connected to the capacitor need to be limited in length in order to avoid the unusually high noise in the probe response[17,18,19,20], this restricts their applicability in large or deep fluidized beds. The second disadvantage is the need for an extremely sophisticated and expensive instrumentation[21,22,23]. Exhaustive calibrations of the probe for each solid-fluid system and possible for every operating condition, particularly temperature and pressure, is the third diadvantage. The fourth disadvantage is the probe may be too large in dimensions for undisturbed measurements in a fluidized bed[24,25,26,27].

An inductance probe requires the bed materials to be susceptable to a magnetic field. Cranfield devised a small probe with a tip that functions rather like a head on a magnetic tape recorder[28]. The probe can be used to detect the presence of ferromagnetic articles. When the bed consists of particles with ferromagnetic properties, the signal at the probe is a direct indication of whether a bubble or the emulsion phase is present.

Optical probes suffer very litte from previous probes mentioned shortcomings and are thus the most versatile in application. Yasui and Johanson[29], Winter[30] and Yoshida[31] measured the presence of bubbles by light transmission. The articles from Winter made use of fiber optics bundles and the work Yasui and Johanson used quartz rods.

With all this, there is a need for a more exhaustive collection and analysis of data on the bubble characteristics of fluidized beds for a more precise understanding of many fluidization phenomena. Our current knowledge on bubble characteristics is mostly based on a limited number of data collected in small laboratory units. In addition to this, it is also necessary to continuously or periodically monitor the bubble behaviors of many industrial fluidized bed reactors for a better control and operation of such units.

An optical probe, derived from S. Dutta and C. Y. Wen's design[32], is devised and a new probing technique and instrumentation are developed from this investigation. This new probing system which overcomes most of the previously mentioned disadvantages and permits on-line monitoring of all major bubble characteristics continuously and simultaneously.

Chapter II

INSTRUMENTATION AND PROBING TECHNIQUE

INSTRUMENTATION

To remove some uncertainties and disadvantages associated with existing techniques and develop a device which gives accurate bubble sizes, shapes, velocities and frequencies in a fluidized bed the following conditions must be satisfied:

1. The probes must be capable of telling whether the center of a striking bubble is rising up along the probe's vertical axis.
2. The timing of the bubble reaching and leaving the probe must be accurately determined.

In order to achieve the first goal, a three-dimensional optical probe is designed. The construction details of the 3-D probe are shown in Figure 3. There are four tiny lights emitting diodes (Motorola LED-50) on the probe which acts as a light source. The four sensing elements are LS-400 photo-cells of about 1 mm in diameter and 8 mm in length. One LED matches one photo-cell to form a sensor. For all sensors, LED and photo-cells are separated from each other by a distance of about 2.5 mm. The distance between

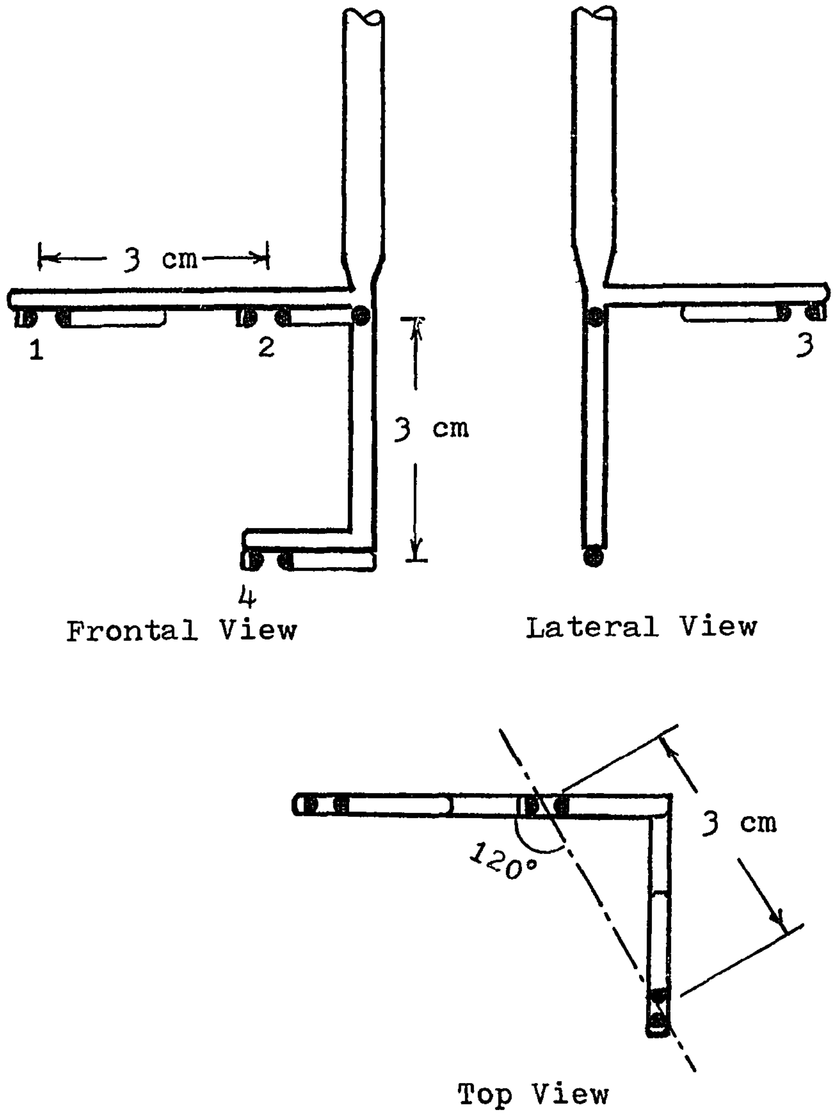

Figure 3. Schematic diagram of 3-D probe.

each sensor is 3 cm. LED and photo-cells are glued on the stainless steel frame and coated with epoxy to increase its strength. The probe is connected so that each sensor forms part of an electrical circuit whereby current flows from an external D.C. power supply. While a sensor resides in the transparent phase it will develop a voltage across the photo-cell and thus generate a signal.

The two sensors which are not lined up on the probe's vertical axis are used to judge whether the strikng bubble is rising up along the probes vertical axis. If a bubble is rising along the probe's vertical axis, the signals generated by those two sensors which are not lined up on the probe's axis should be the same.

To achieve the second goal, a comparator circuit with an adjustable reference level as shown in Figure 4 is developed. LM339 quad comparator has four independent voltage comparators in a single package. This is merely a coincidence with the four channel probe. The comparator circuit is used to obtain an almost perfectly square wave form. Generation of square waves is necessary for on-line analysis of the data by a microprocessor. Square waves are also much easier to analyze manually.

The probe assembly is the combination of the probe and the comparator circuits. This device has been coupled to an INTEL 8085 microprocessor with timer circuitry for fast, accurate conversion of analog voltage signals to binary digits and with software to discriminate the signals

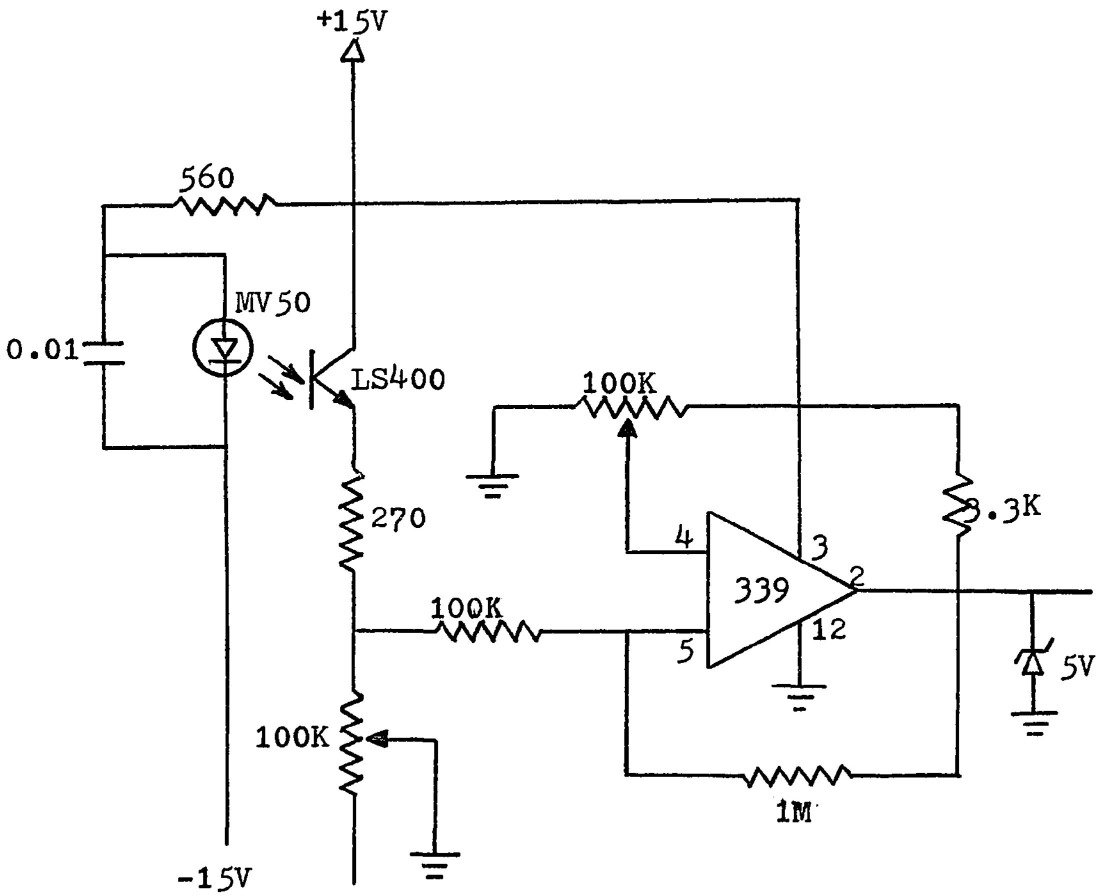

Figure 4. The comparator circuit for signal processing.

generated by the bubbles whose rising path is not coincident with the probe's axis. The software discriminator selects only those bubbles whose centers are rising along the probe's axis and displays all of the information deemed necessary for calculations of bubble size, shape, velocity and frequency. Then, the Univac 90/80-4 computer is programmed to do all of the calculations. The timer circuitry is shown in Figure 5. It is a combination of four 8253 programmable interval timers with some logic gates and resistors. The interval is set to be 2 milliseconds. The Figure 6 shows a block diagram of this whole system, and further details are given in Appendix A, B and C.

Probing Technique

The probing technique may be illustrated by considering the voltage pulse sequence which is generated by a bubble which is rising through the probe. An arbitrary reference voltage for comparator ciurcuits is defined as

$$V_L < V_R < V_H \qquad (1)$$

If all sensors enter a bubble and thus develop a voltage across the photo-cells which is higher than the reference voltage V_R, the signals should be at a high and vice versa. An ideal sequence generated by the probe when a bubble center is rising along the probe's vertical axis is shown in Figure 7, where the pulses are numbered with

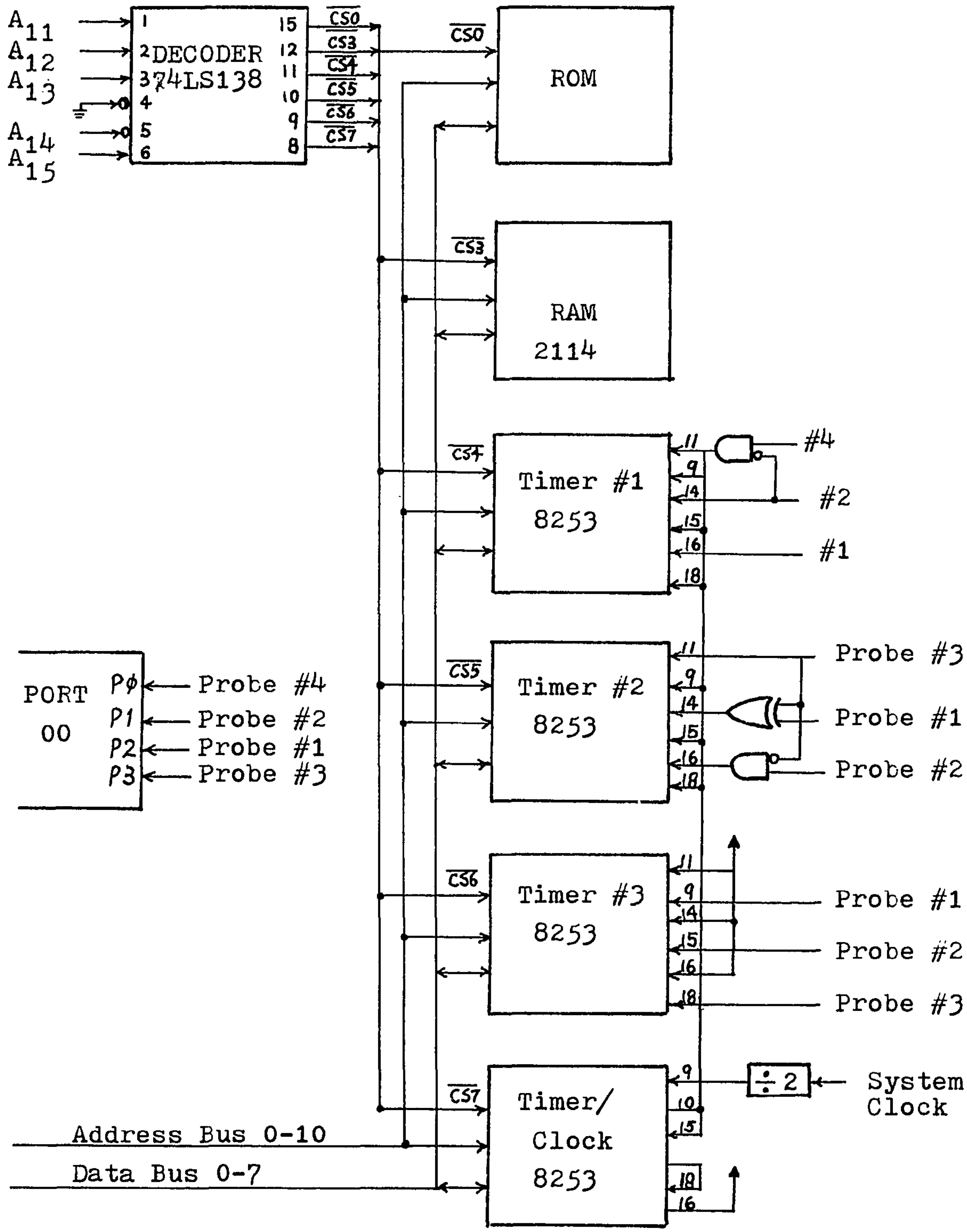

Figure 5. Schematic diagram of timer circuitry.

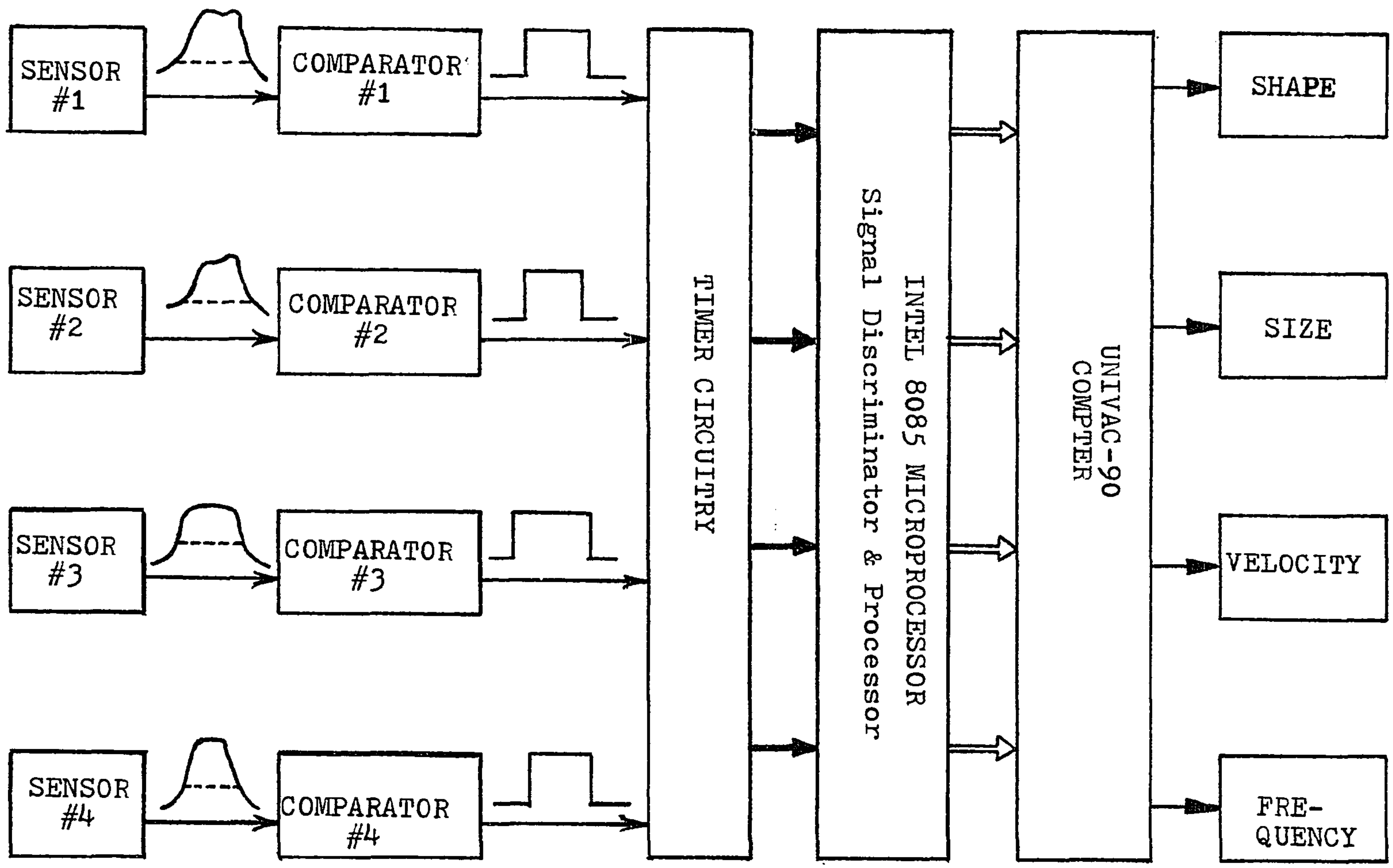

Figure 6. Block diagram of the set-up for on-line monitoring of bubble characteristics.

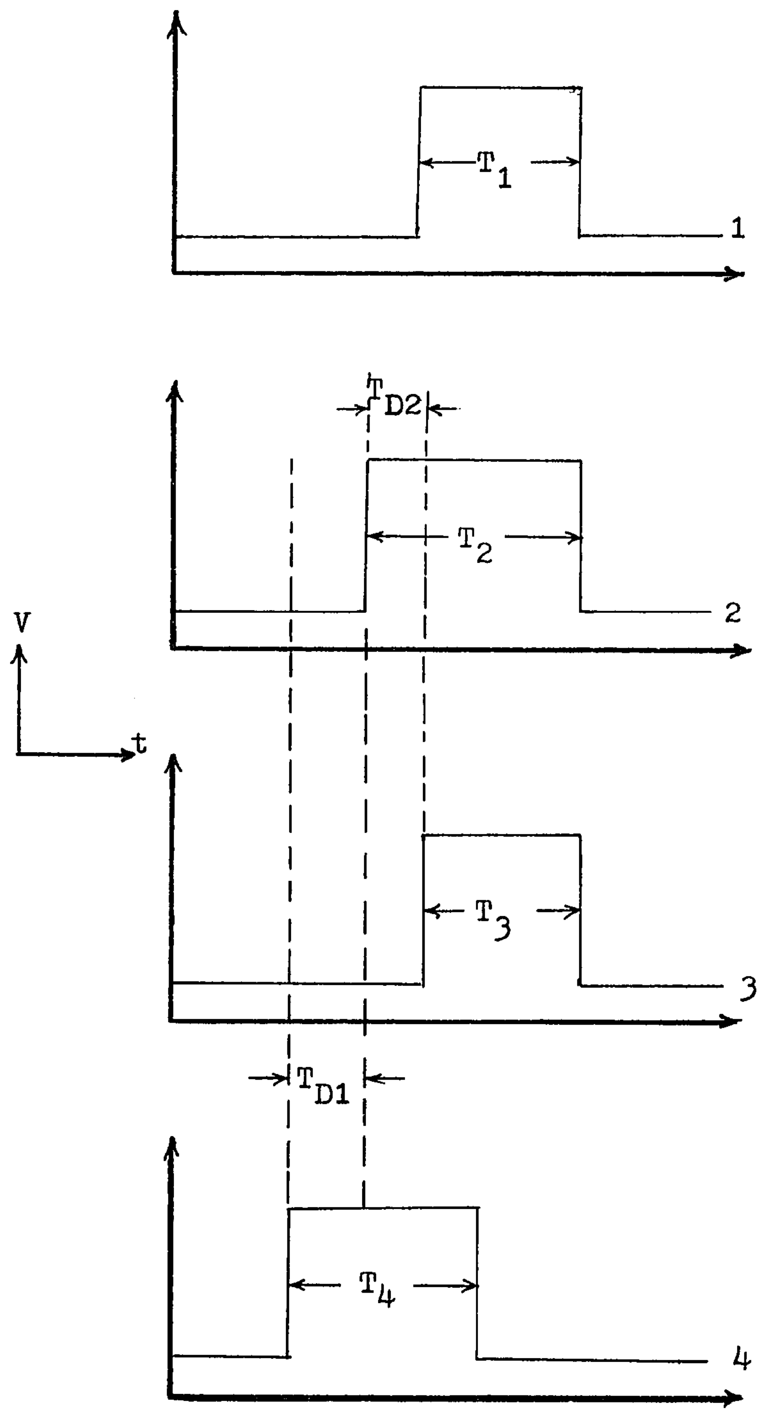

Figure 7. An ideal signal sequence generated by a bubble whose center rising along the probe vertical axis.

reference to the number of the sensors shown in Figure 3. Figure 8 shows that an ideal 3-D bubble is rising through a probe. The voltage sequence generated by the probe should follow the eight steps which are shown in Table 1. Based on these logical steps shown in Table 1, the software signal discriminator has been developed and shown in Appendix B. If the signal sequence is not following the eight logical steps, the signals will be deleted. Thus all the timers will be reset and ready for the next sequence coming in. If the signal sequence follows the eight steps in Table 1, the last thing needed to be checked is whether the signal sequence has been generated by a single bubble. Only the center of a single bubble rising along the probe's axis will show

$$T_1 < T_2 \tag{2}$$

and

$$T_3 < T_2 \tag{3}$$

where T_1, T_2 and T_3 are defined in Figure 7.

Bubble Velocity

The time delay T_{D1} is defined in Figure 7. For an accurately known distance (d) between sensor #2 and sensor #4, defined in Figure 3, the bubble velocity is given by

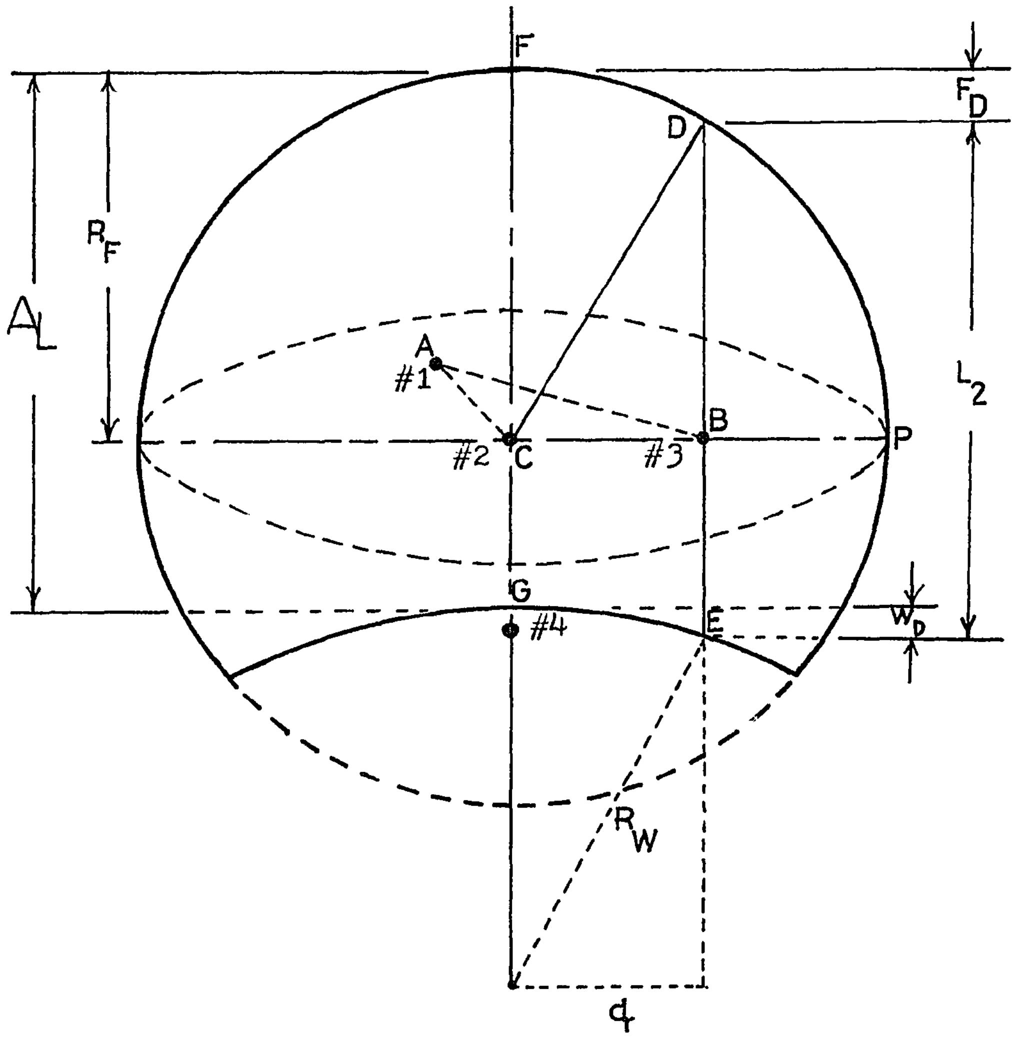

Figure 8. An ideal 3-D bubble rising through a 3-D probe.

Table 1

Probe Signal Sequence Generated by a Single Bubble Whose Center Rising Along the Probe Axis

Step	Channel 1	Channel 2	Channel 3	Channel 4
1	V_L	V_L	V_L	V_L
2	V_L	V_L	V_L	V_H
3	V_L	V_H	V_L	V_H
4*	V_L	V_H	V_H	V_H
5	V_H	V_H	V_H	V_H
6	V_L	V_H	V_H	V_L
7	**	**	**	**
8	V_L	V_L	V_L	V_L

Notes: * Either Channel 1 at V_L and Channel 3 at V_H or Channel 1 at V_H and Channel 3 at V_L

** Either V_H or V_L

$$U_B = \frac{d}{T_{D1}} \tag{4}$$

Bubble Size and Shape

The central vertical length of a bubble is given by

$$A_L = U_B \cdot T_2 \tag{5}$$

where T_2 is defined in Figure 7. The time delay T_{D2} is also defined in Figure 7. Thus, the elevation difference between the center of the bubble frontal surface and the bubble surface point at a lateral distance d_r from the bubble vertical axis is given by

$$F_D = U_B \cdot T_{D2} \tag{6}$$

The bubble vertical chord length at a lateral distance d_r from bubble vertical axis is then given by

$$L_2 = U_B \cdot T_3 \tag{7}$$

The frontal surface of the bubbles are essentially spherical but with an indented base of greater or lesser degree as seen in Figure 2. This is the idealized or perhaps stable shape of an isolated bubble and can often be observed. Then a spherical radius R_F is largely defined from the ideal bubble. According to Figure 8

$$CF = CD = R_F \tag{8}$$

$$CB = d_r \tag{9}$$

$$BD = R_F - F_D \tag{10}$$

and

$$CD^2 = CB^2 + BD^2 \tag{11}$$

or

$$R_F = \sqrt{(R_F - F_D)^2 + d_r^2}. \tag{12}$$

By itteration, R_F can be determined. If the wake surface is also spherical, the radius of the wake surface R_W can be determined by the same method as solving for R_F.

In order to process the data further, a bubble shape determination procedure is developed to select between eight shapes to secure the best fit to the calculated coordinates, A_L, F_D and L_2.

For a spherical cap bubble

$$A_L < 2R_F \tag{13}$$

and

$$R_B = R_F \tag{14}$$

where R_B is the superficial radius.

A spherical cap bubble with $R_B < (A_L + H_W) < 2R_B$ and a dented bottom is shown in Figure 9. Thus

$$H = 2R_B - A_L \tag{15}$$

$$R_W^2 - (R_W - H_W)^2 = r^2 \tag{16}$$

and

$$R_B^2 - \left[R_B - (H - H_W)\right]^2 = r^2 \tag{17}$$

By solving Eq. (16) and (17) the value of r and H_W can can be determined. The volume of a sphere is

$$V_1 = \frac{4}{3}\pi R_B^3. \tag{18}$$

The volume occupied by wake in Figure 9 may be calculated by

$$V_2 = \frac{\pi}{6} H_W (3r^2 + H_W^2) + \frac{\pi}{6} (H - H_W) \left[3r^2 + (H - H_W)^2\right]. \tag{19}$$

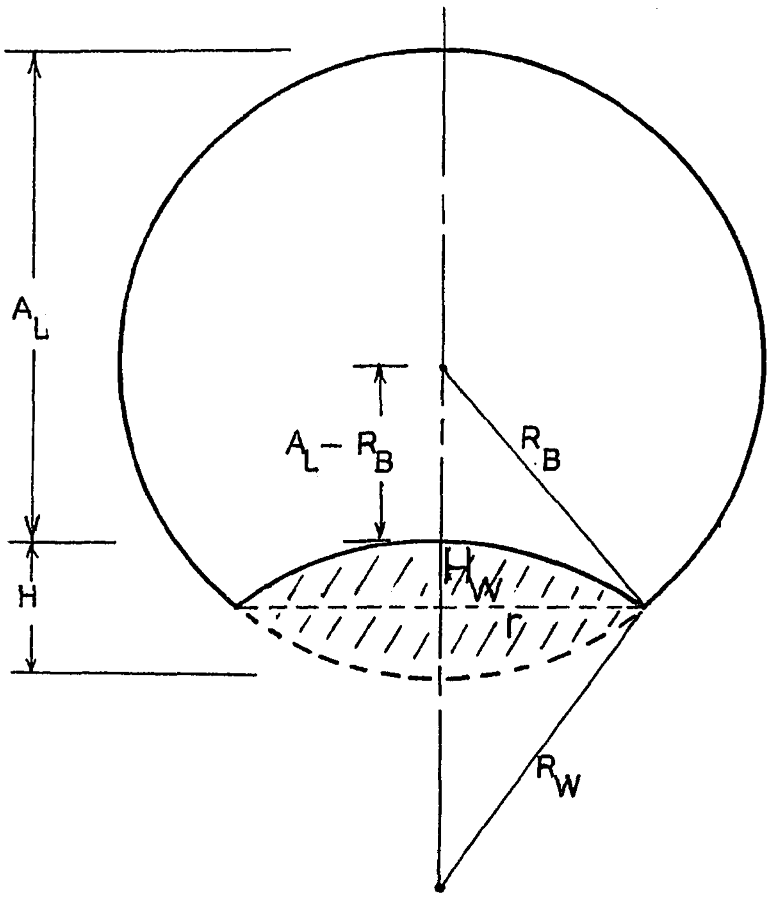

Figure 9. A spherical cap bubble with its axial length grater than its superficial radius and an indented bottom.

Hence, the bubble volume is

$$V_B = V_1 - V_2 \tag{20}$$

For a spherical cap bubble with $R_B < (A_L + H_W) < 2R_B$ and flat bottom, the shape is shown in Figure 10. The volume of the bubble wake is

$$V_3 = \frac{\pi}{6} H_W (3r^2 + H_W^2). \tag{21}$$

Thus, the bubble volume can be determined by equations (18) and (21).

A spherical segment bubble with $(A_L + H_W) < R_B$ and dented bottom is shown in Figure 11. By solving

$$R_B^2 - (R_B - A_L - H_W)^2 = r^2 \tag{22}$$

and

$$R_W^2 - (R_W - H_W)^2 = r^2 \tag{23}$$

simultaneously, the r and H_W can be determined.

The volume occupied by the shaded area becomes

$$V_4 = \frac{\pi}{6} H_W (3r^2 + H_W^2). \tag{24}$$

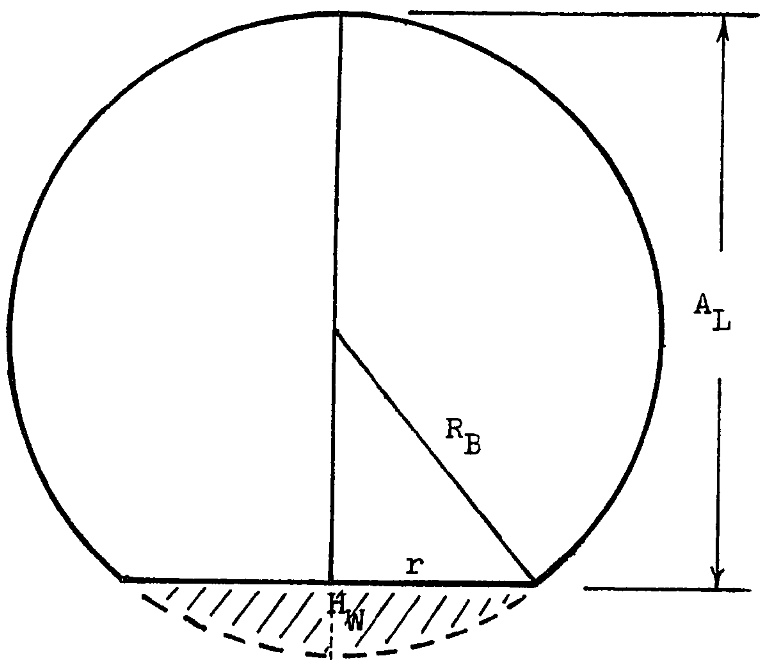

Figure 10. A spherical cap bubble with its axial length greater than its superficial radius and a flat bottom

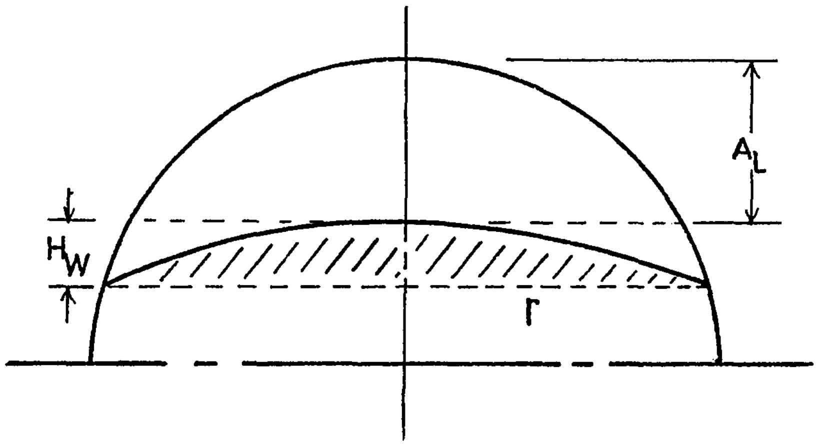

Figure 11. A spherical cap bubble with its axial length less than its superficial radius and an indented bottom.

The volume of the whole spherical segment in the Figure 11 is

$$V_5 = \frac{\pi}{6} (A_L + H_W) \left[3r^2 + (A_L + H_W)^2\right]. \qquad (25)$$

Thus, the volume of the Bubble is

$$V_B = V_5 - V_4 \qquad (26)$$

Figure 12 shows the shape of a spherical segment bubble with a flat bottom and A_L R_B. Where r value can be solved by

$$R_B^2 - (R_B - A_L)^2 = r^2 \qquad (27)$$

Then, the bubble volume is

$$V_B = \frac{\pi}{6} A_L (3r^2 + A_L^2) \qquad (28)$$

A semi-spherical bubble is shown in Figure 13 where $A_L = R_B$. The volume of this bubble is

$$V_B = \frac{4}{6} \pi A_L^3 \qquad (29)$$

Another semi-spherical bubble with a dented bottom

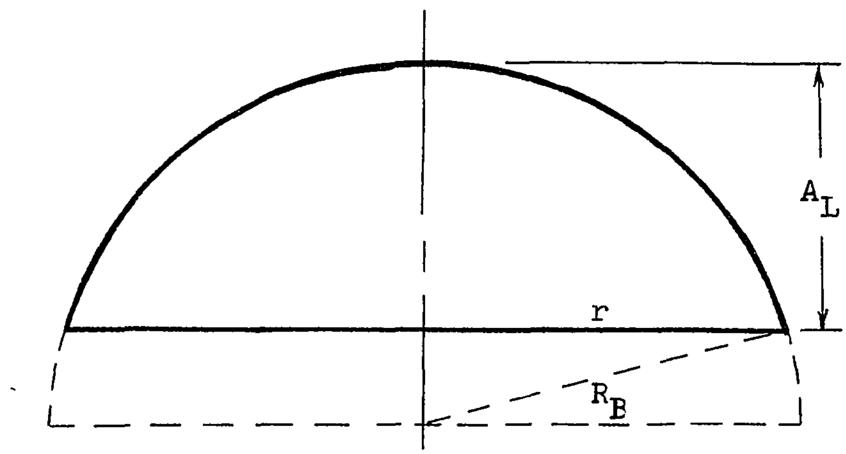

Figure 12. A spherical cap bubble with its axil length less than its superficial radius and a flat bottom.

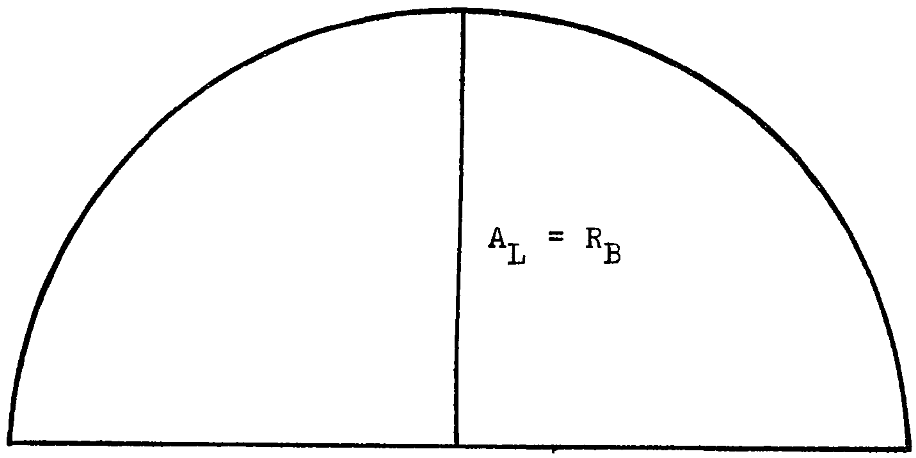

Figure 13. A semi-spherical bubble with a flat bottom.

is shown in Figure 14. The volume of wake becomes

$$V_6 = \frac{\pi}{6} H_W \left(3R_B^2 + H_W^2\right) \tag{30}$$

Thus, the volume of this bubble is

$$V_B = \frac{4}{6} \pi R_B^3 - \frac{\pi}{6} H_W\left(3R_B^2 + H_W^2\right) \tag{31}$$

When A_L is greater than $2R_F$, the shape of the bubble is like a parabolic body. The Figure 15 shows a parabolic bubble. The bubble volume is

$$V_B = \int_0^{A_L} \pi r^2 \cdot dA_L$$

$$= \int_0^{A_L} \pi(kA_L)\, dA_L$$

$$= \frac{k\pi}{2} A_L^2 \tag{32}$$

A parabolic bubble with a dented bottom is shown in Figure 16. By solving

$$k(A_L + H_W) = r^2 \tag{33}$$

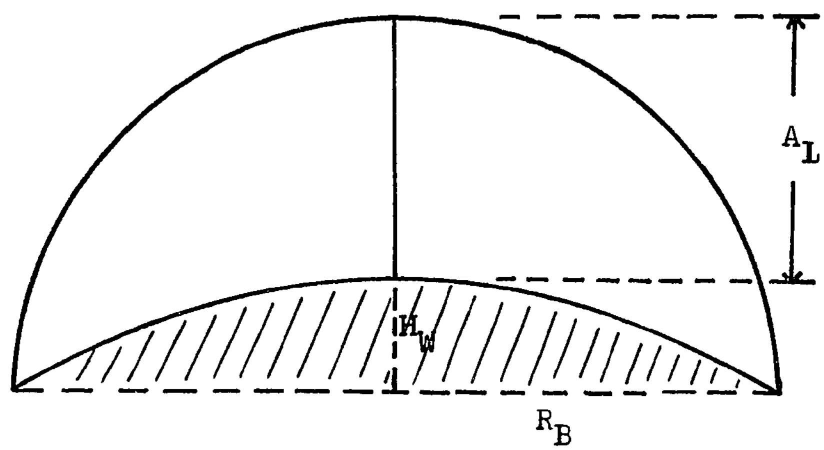

Figure 14. A semi-spherical bubble with an indented bottom.

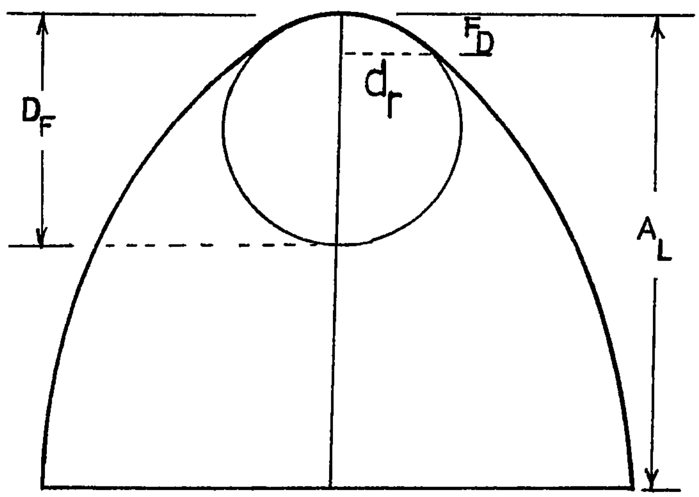

Figure 15. A paraboloid bubble with a flat bottom.

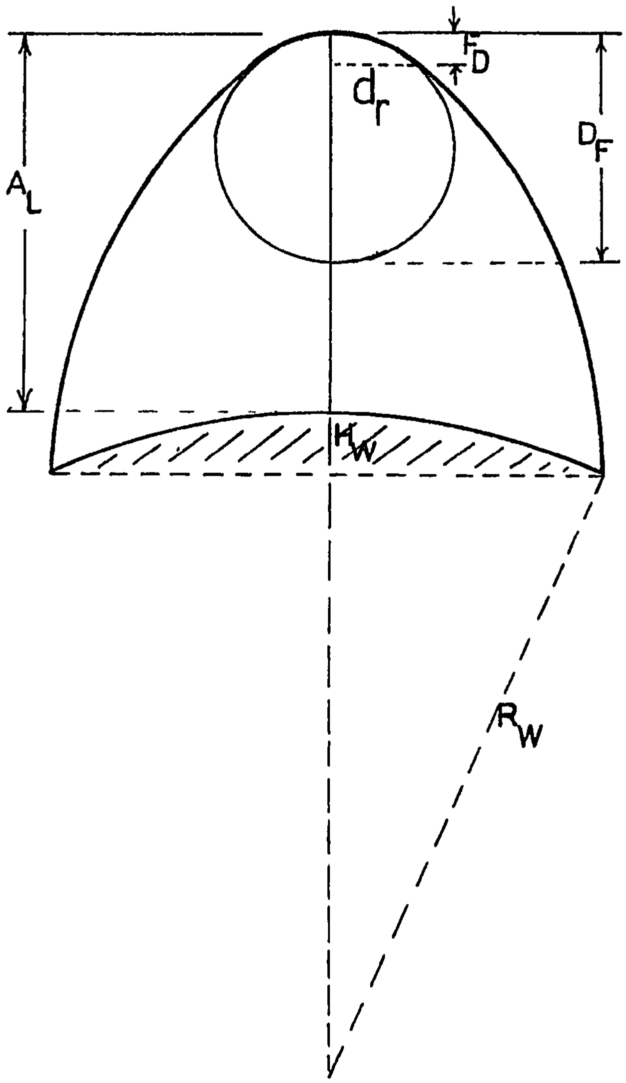

Figure 16. A paraboloid bubble with an indented bottom.

and

$$R_W^{\;2} - (R_W - H_W)^2 = r^2 \qquad (34)$$

simultaneously, the H_W and r can be calculated. Thus, the volume of this bubble becomes

$$V_B = \frac{k\pi}{2}(A_L + H_W)^2 - \frac{\pi}{6} H_W(3r^2 + H_W^{\;2}) \qquad (35)$$

Once the bubble volume is determined, the equivalent spherical bubble diameter can be calculated by

$$D_E = \left[\frac{6V_B}{\pi}\right]^{1/3}. \qquad (36)$$

<u>Bubble Frequency</u>

Bubble frequency is defined in terms of the number of bubbles passing through the #2 sensor per second at certain positions within a fluidized bed.

The system can examine all four channels of analogic signals at a rate of 1.1 KH_Z which is sufficient to resolve bubble velocity up to 2 m/s with a 3 cm distance between sensor #2 and #4. The bubble characteristics calculation program is shown in Appendix A. The assembly language signal discriminator with frequency counter program and signal processing program are all shown in Appendix B.

Chapter III

EXPERIMENTAL FACILITY

The experimental facility used in this investigation consists of eight primary components, namely, (1) probe assembly and signal processing device, (2) two-dimensional fluidized bed, (3) three-dimensional fluidized bed, (4) bed materials, (5) probe positioning mechanism, (6) air supply and humidification system, (7) photographic equipment and supplies, and (8) power supply systems. Detailed design of the probe assembly, timer circuitry and signal discriminator have been given in Chapter II precisely. In this chapter the remaining seven components are being described.

Two - Dimensional Fluidized Bed

For the qualitative investigation of bubble characteristics by cine photography a transparent 2-D bed is used. The 2-D bed is made of 1.27 cm thick plexiglas plates. The exact dimensions of a bed are given in Figure 17. Figure 18 shows a photograph of 2-D fluidized bed. The gas distributor is a 1.905 cm thick aluminum plate with a single row of 0.3175 cm-diameter holes at a 1.5 cm center to center spacing.

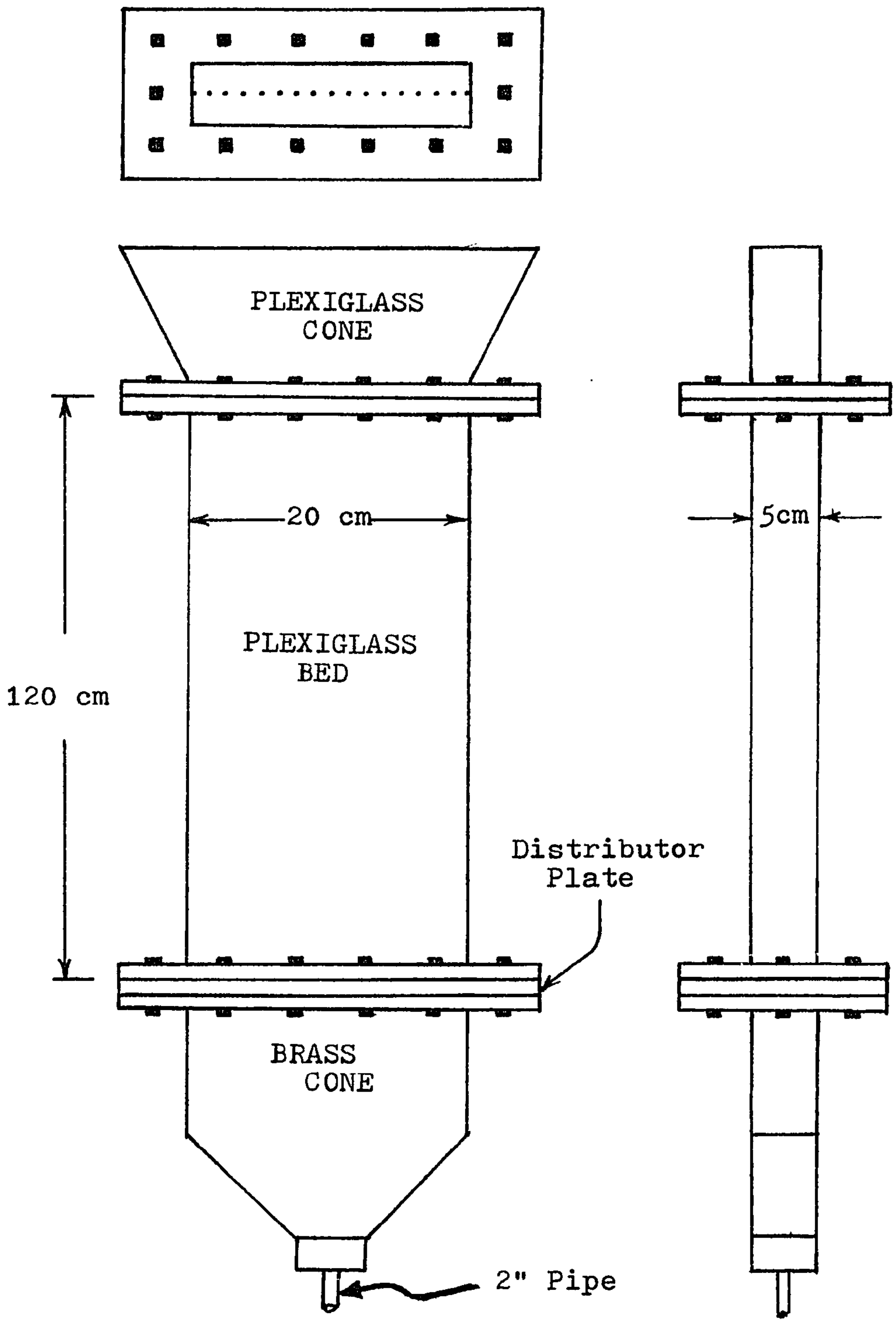

Figure 17. Schematic diagram of the 2-D fluidized bed.

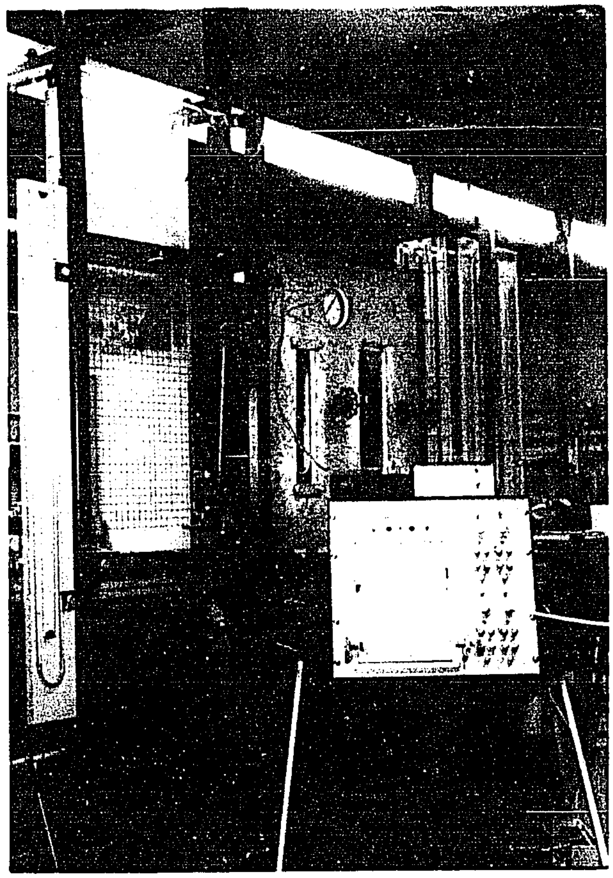

Figure 18. A photograph of the 2-D fluidized bed set-up.

Three-Dimensional Fluidized Bed

A 3-D bed is used for the quantitative study of the bubble characteristics by probe. Figure 19 shows the 3-D fluidized bed with 40 cm x 20 cm x 120 cm in dimensions and made of 1.27 cm thick plexiglass plates. The gas distributor is a perforated and 1.905 cm thick aluminum plate. Its detailed design is shown in Figure 20.

Bed Material

The solid used in this research is Potter Industries Inc., P series glass beads. The sizes of the glass beads used in 2-D bed are given in Table 2.

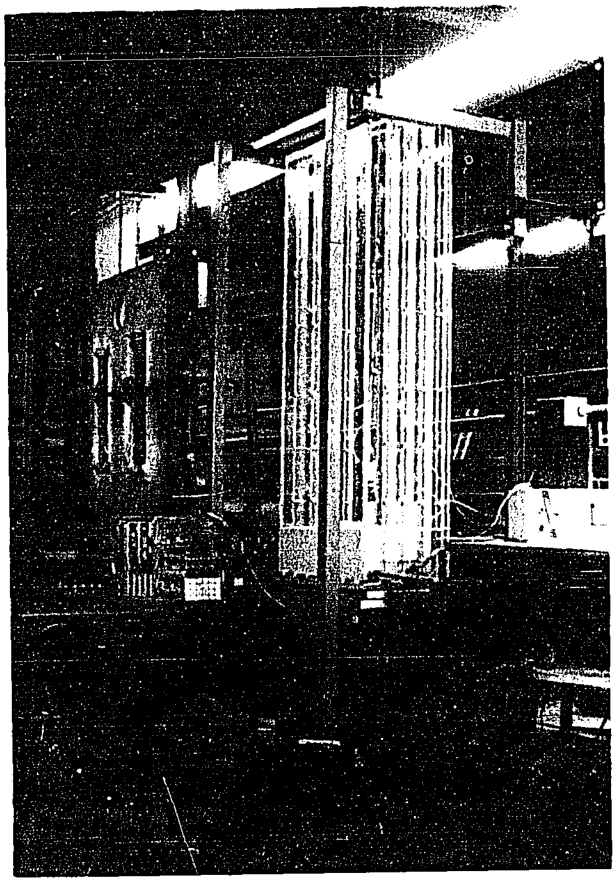

Figure 19. A photograph of the 3-D fluidized bed set-up.

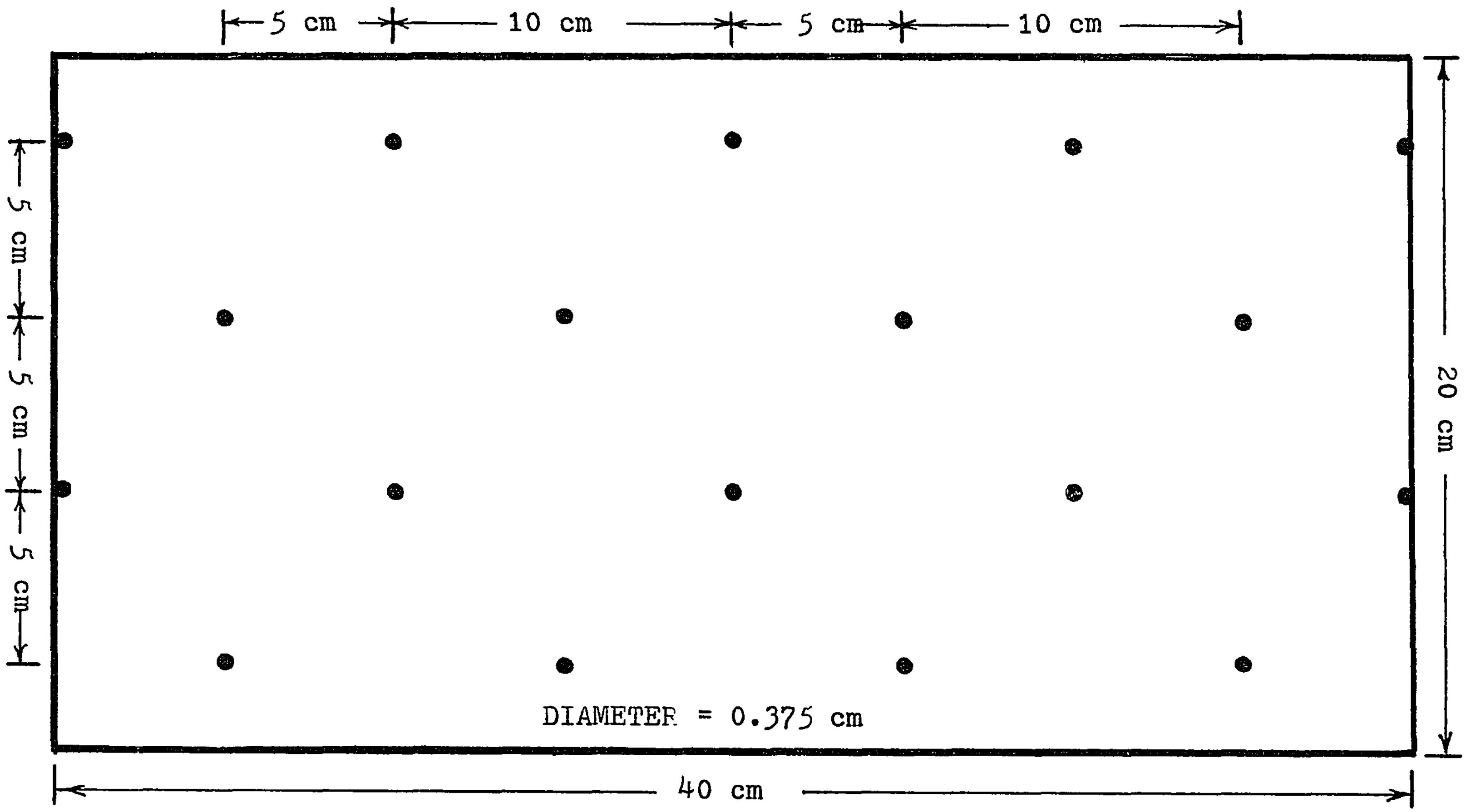

Figure 20. Schematic diagram of the gas distributor of the 3-D fluidized bed.

Table 2

The Glass Bead Sizes Used
in 2-D Fluidized Bed

Solid	Size (μm)
P - 047	1180 - 710
P - 033	850 - 500
P -0230	600 - 425
P -0140	355 - 250
P - 004	106 - finer

Only the glass beads with one size of 355 - 250 μm are used in 3-D fluidized bed.

Probe Positioning Mechanisms

The positioning mechanism is employed to anchor the probe in any specific position within the bed precisely. It consists of a 120 cm long stainless steel rod with a diameter of 1.27 cm. The probe is securely mounted on one end of this rod. A shorter rod, 60 cm in length and 1.27 cm in diameter, is perpendicularly and adjustably connected to the longer rod by a Fisher strut connector. The shorter rod is fastened horizontally on top of the 3-D fluidized bed to any desired position.

Air Supply and Humidification System

The air flow for the 2-D and 3-D fluidized beds is supplied by the central compressed air system. Figure 21 shows a schematic diagram of the air supply and humidification system. An oil filter and a dust filter are used to clean the air. The air flow rate is controlled with a gate valve and measured by a rotameter. The pressure of the air is regulated by a pressure regulator and measured by a pressure gauge. The air is moistened by passing it through a humidifier. By controlling the mixing ratio of dry air and moistened air, the optimized air humidity can be reached and maintained. Sticking of the solid particles

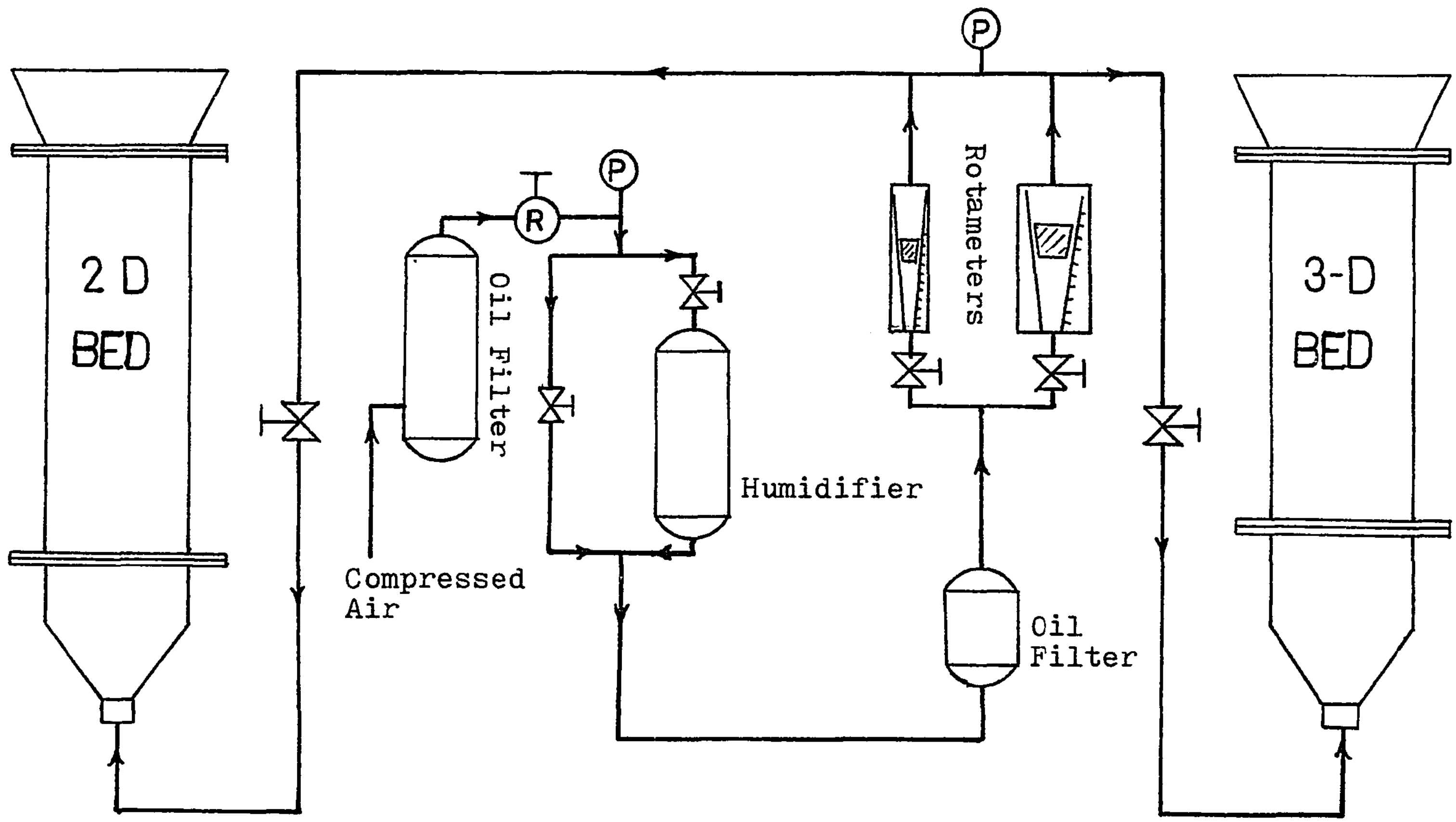

Figure 21. Flow diagram of the air supply and humidification system.

on the wall, due to static electricity, is eliminated by using humidified air. This helps in taking clearer pictures of bubbles by cine camera.

Photographic Equipment and Supplies

The cine camera used is a Kodak model K-100 which is capable of taking pictures up to 64 frames per second. The incident light and the reflected light intensities are measured by a Sekonic model L-398 exposure meter. After combining ASA film sensitivity and shutter speed the exposure meter can directly determine the aperture value. ACME-LITE Model 220 Duolite is used as a photographic light. It is directly on the back of 2-D fluidized bed in order to get a bright bubble image. Kodak Tri-X reversal film 7278 is used in this investigation. The films are analyzed by a L-W 224-ATHENA MKV Photo-Optical Data Analyzer which has automatic frame rates of 1 - 2 - 4 - 6 - 8 - 12 - 18 - 24 frames per seconds, plus stop for still picture viewing and unlimited hold time without loss of light or damage to film.

Power Supply System

A Radio Shack 15 volts DC power supply is used to supply the power which is needed by both LED's and photocells. The power needed for operating the Intel 8085

Microprocessor and the timer circuitry are supplied by a Power/Mate Corp. 5 volts regulated DC power supply.

Chapter 4

EXPERIMENTAL PROCEDURES

An experimental run is begun with filling a bed material in either the 2-D or 3-D fluidized bed to the 50 cm level height above the distributor. Before the air is turned on the water level inside the humidifier **was checked.** The air supply is then turned on, while the dry air and the moistened air flow rates are regulated at the same time to optimize the moisture content in the air.

Qualitative Investigation

The two-dimensional fluidized bed is used for qualitative investigation. While the photographic light is turned on, the light intensity is measured and the aperture value is determined. The camera frame rate is set to be 24 frames per second. The experiment is conducted at different fluidization velocity and with different bed material. The cine photographs are taken during the experiment. The bubble shape, drifting, splitting and coalescence are then analyzed by film observation.

Quantitative Investigation

For quantitatively investigating bubble characteristics the 3-D fluidized bed is used. This investigation employs the newly developed probing technique which has been discussed in the previous chapter. First of all, the probe is inserted at a certain location within the bed, and the power supplies are then activated to maintain the operation of all the electronic devices. T_1, T_2, T_3, T_{d1}, and T_{d2} are recorded and sent to main frame computer for bubble characteristics calculation. The bubble frequency distribution inside the bed and bubble size distribution at certain locations within the bed can be analyzed statistically. The bubble velocity can also be correlated with the bubble size.

Chapter V

RESULTS AND DISCUSSION

Qualitative Investigation

The general nature of bubbles in gas-fluidized bed are in some respects remarkably like large gas bubbles in a liquid. A typical two-dimensional bubble in a gas-fluidized bed has already been shown in Figure 2. The bubbles are essentially spherical but with an indented base of greater or lesser degrees as seen in Figure 8. This is the idealized or perhaps stable shape of the bubbles.

Large distortions of shape occur as bubbles come closer to one another and to the walls. It is not possible to describe the distortions caused by the walls but the general effect can usually be imagined by analogy with liquid bubbles[33].

The major effect of bubbles coming closer together is to promote coalescence during which considerable distortion can occur. This phenomena is more likely to happen at a higher position. Thus, no consistant pattern and basic shape may be found in the higher region of the fluidized beds. However, for all fluidized systems, basic shapes do exist. The basic shapes observed in the 2-D fluidized bed have been described in Figure 9 through Figure 16.

Based on these eight basic shapes, the shape fitting process has been developed for the probing technique.

The average bubble size increases quite rapidly with height mainly as a result of coalescence. It also increases as a result of overall gas expansion as the pressure decreases with height but this is a small effect except with very dense material or in beds operated at a very low overhead pressure. The coalescence of two originally independent bubbles always occurs in a part-cular way. Figure 22 shows a cine sequence of the bubbles coalescence phenomenon, a larger bubble overtaking and capturing a smaller one. When the captured bubble moves into the rising drift behind the other, it rises rapidly until it gets into the captor. The previous phenomenon occurs very rapidly and the captured bubble elongates considerably in the final stages. The captor distorts very little but may pause slightly at the moment of mergence.

A simple theory has been proposed concerning the stability of bubbles which predicts that there is a maximum stable bubble size[34]. When the size of a bubble is larger than the stable bubble size the bubble splits. Figure 23 is a cine sequence showing a bubble splitting. The upper boundary of the bubble develops a downward pointing cusp which grows rqpidly into a knife like shape. The cusp tends to originate near the forward stagnation

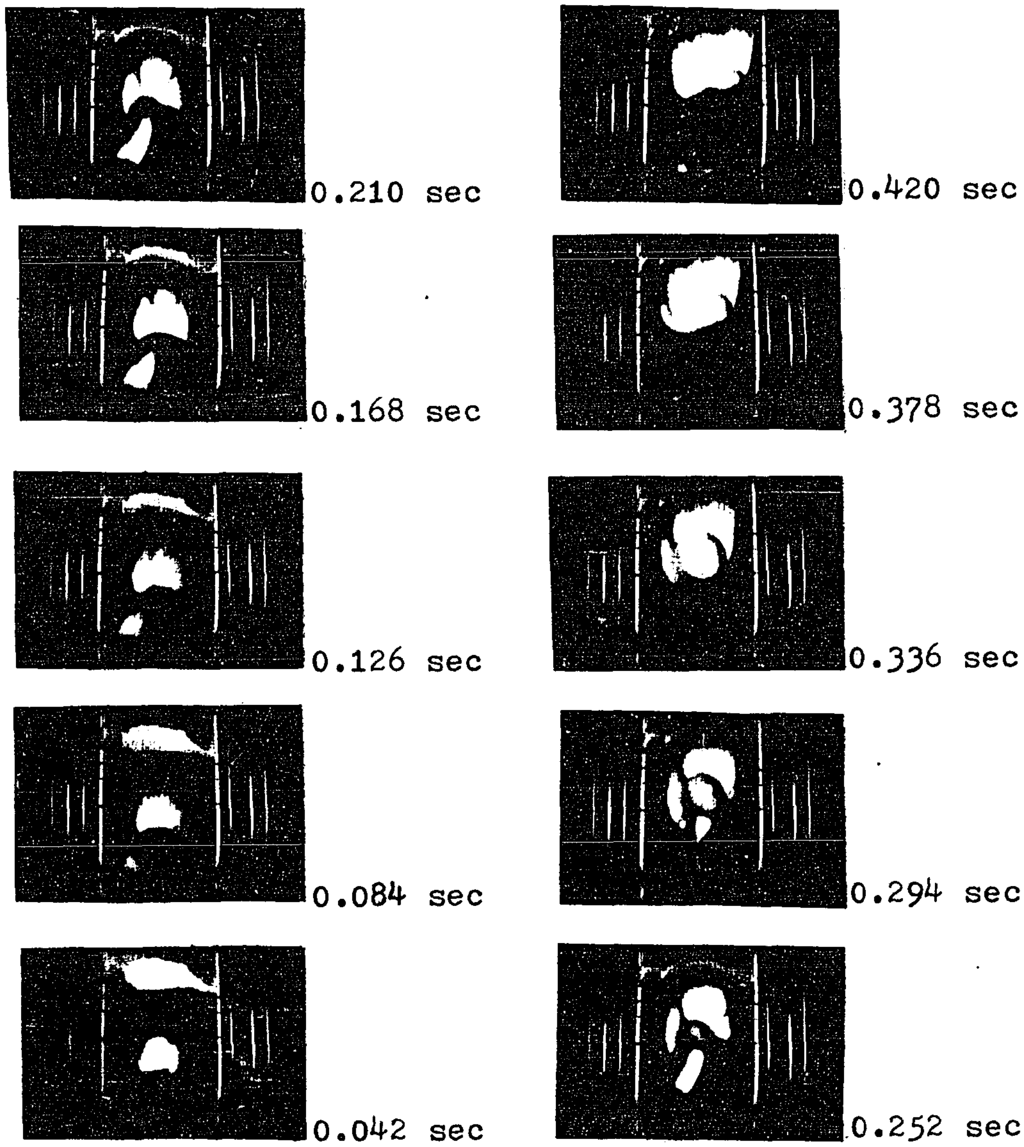

Figure 22. A sequence of bubble coalescence phenomenon.

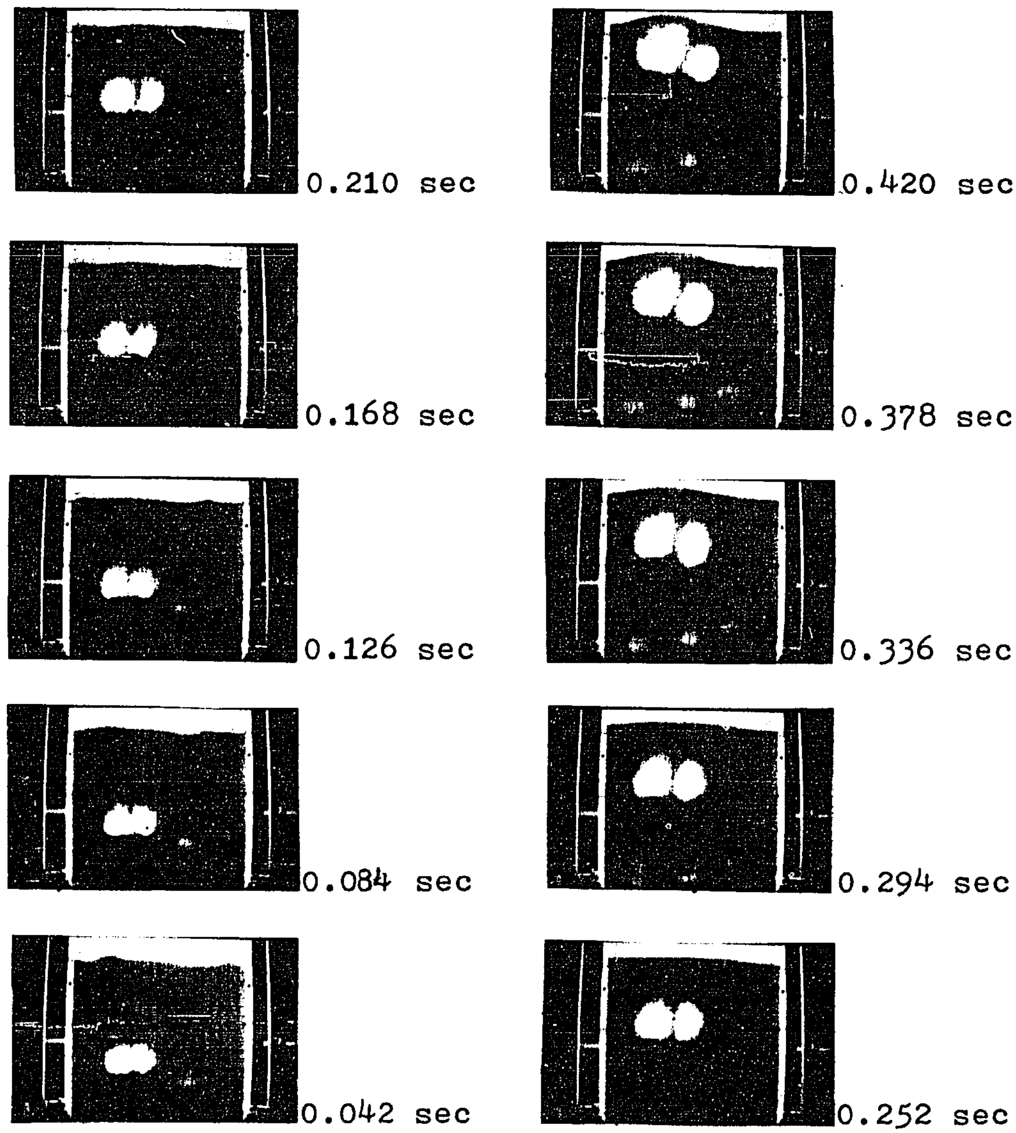

Figure 23. A cine sequence of a bubble splitting.

point and run down to divide the bubble. This vertical splitting is a common phenomenon and few bubble survive long before bifurcating.

Fluidized bed bubbles rise at velocities some tens of centimeters a second and the bigger they are the faster they rise. Velocity also depends on the concentration of bubbles and increases with bed porosity. In other words, the bubble velocity also increases with the gas flow rate.

Quantitative Investigation

Bubble Shapes

The bubble shapes usually are determined by the values of bubble axial length (A_L), frontal surface radius (R_F) and wake surface radius (R_W). Figure 24 shows typical measured bubble shapes. These are very similar to those reported by Rowe and Partridge [8] for single bubbles using X-ray photography. Some bubbles have a flat bottom shape while others have marked concave indentation of the rear surface. When considerable elongation from the spherical shape occurs, it becomes a paraboloid shape.

Bubble Velocities

The measured bubble velocity in the bed and its variation with their computed bubble equivalent spherical

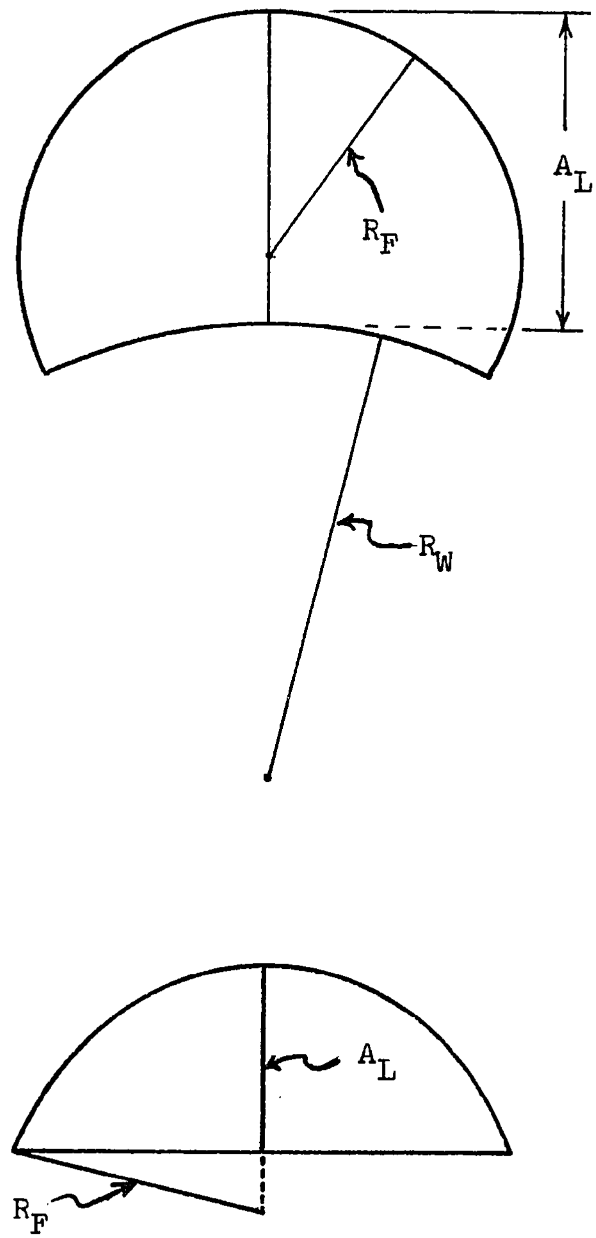

Figure 24. Typical measured bubble shapes.

diameter is shown in Figure 25, where the bubble velocity is calculated from Equation (4). The data represent a sequential sample of about 100 bubbles on the bed centreline and 35 cm above the distributor.

Figures 25 to 27 also indicate the applicability of the Davies-Taylor relationship for spherical cap bubbles[35]. Clearly, this equation was inadequate to explain the variation in mean bubble velocity with position in the bed. The mean bubble velocity increased with the height above the distributor, and decreased with lateral distance from the centreline, which leads one to suppose that macroscopic bed mixing and circulation are influential. The mean bubble velocity is defined in terms of an average bubble velocity of a group of bubbles within certain bubble size range, while the Z_v and Z_1 are defined as the height of the probe above the distributor and the distance between the probe and the bed centreline respectively.

Bubble Size Distribution

A typical bubble size distribution measured by the probe for the fluidized bed is shown in Figure 28, where the characteristic bubble size is the equivalent spherical diameter computed by the shape determination process. These distributions give the bubble number fraction for a particular bubble size at a certain position within the fluidized bed, where the bubble number fraction is

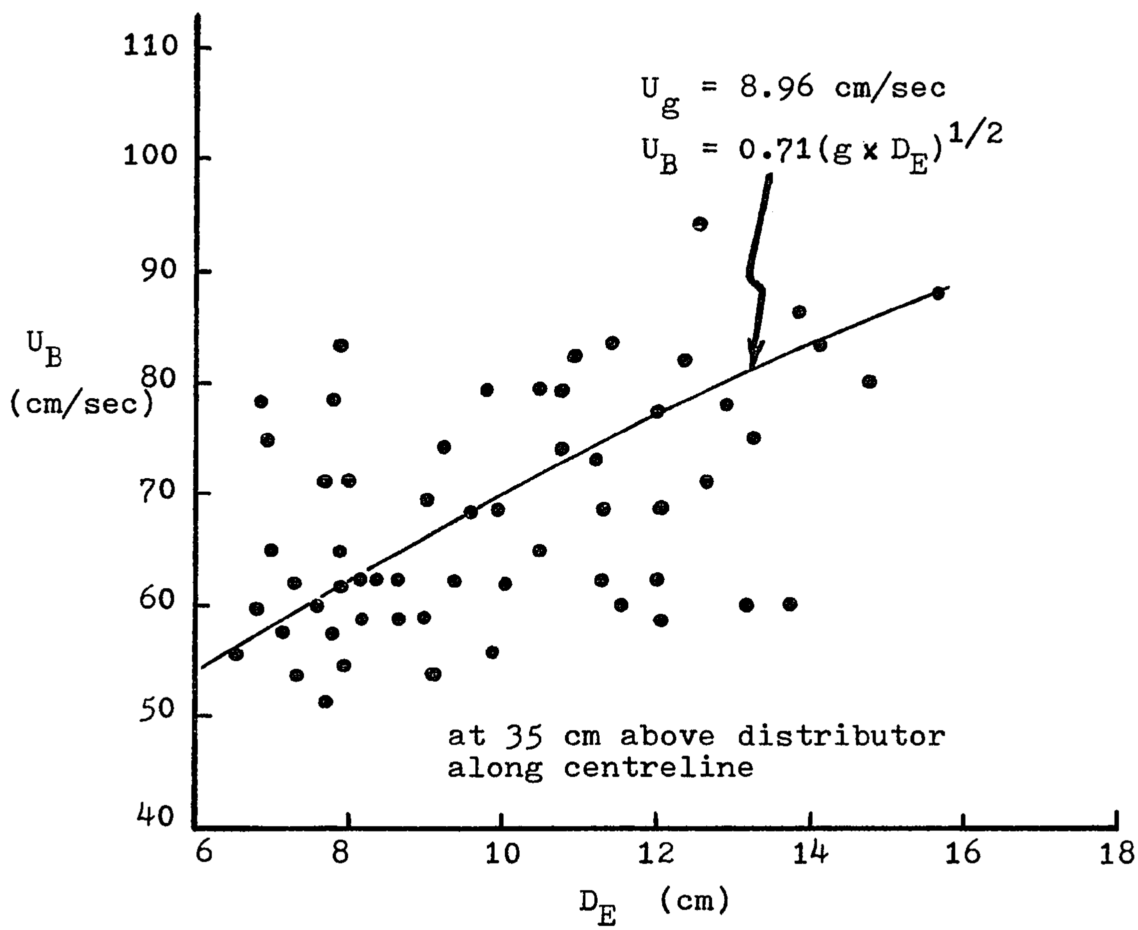

Figure 25. Variation of bubble velocity with equivalent spherical diameter for individual bubbles in the fluidized bed.

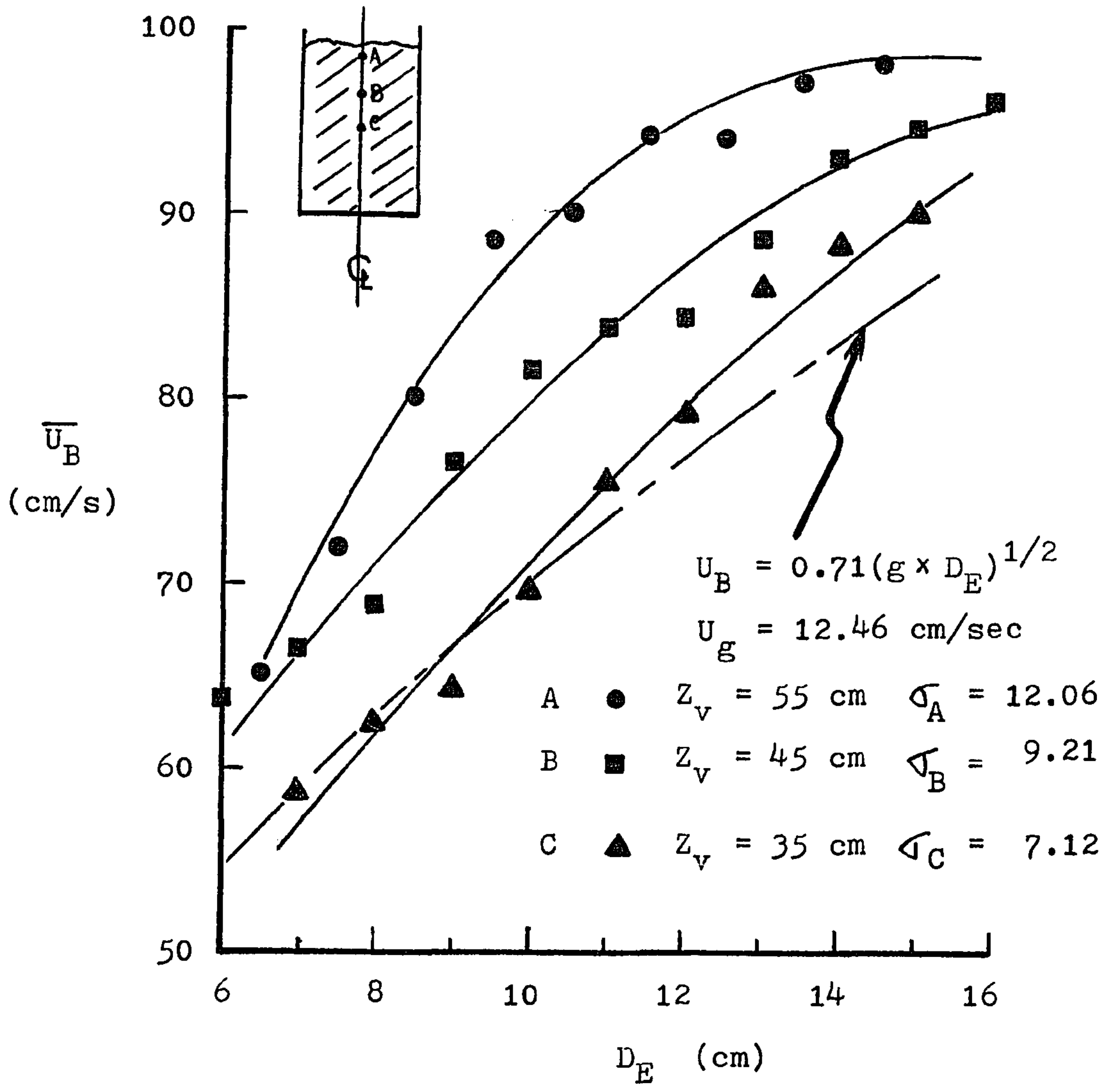

Figure 26. Variation of mean bubble velocity with bubble size and level in the bed on the bed centreline.

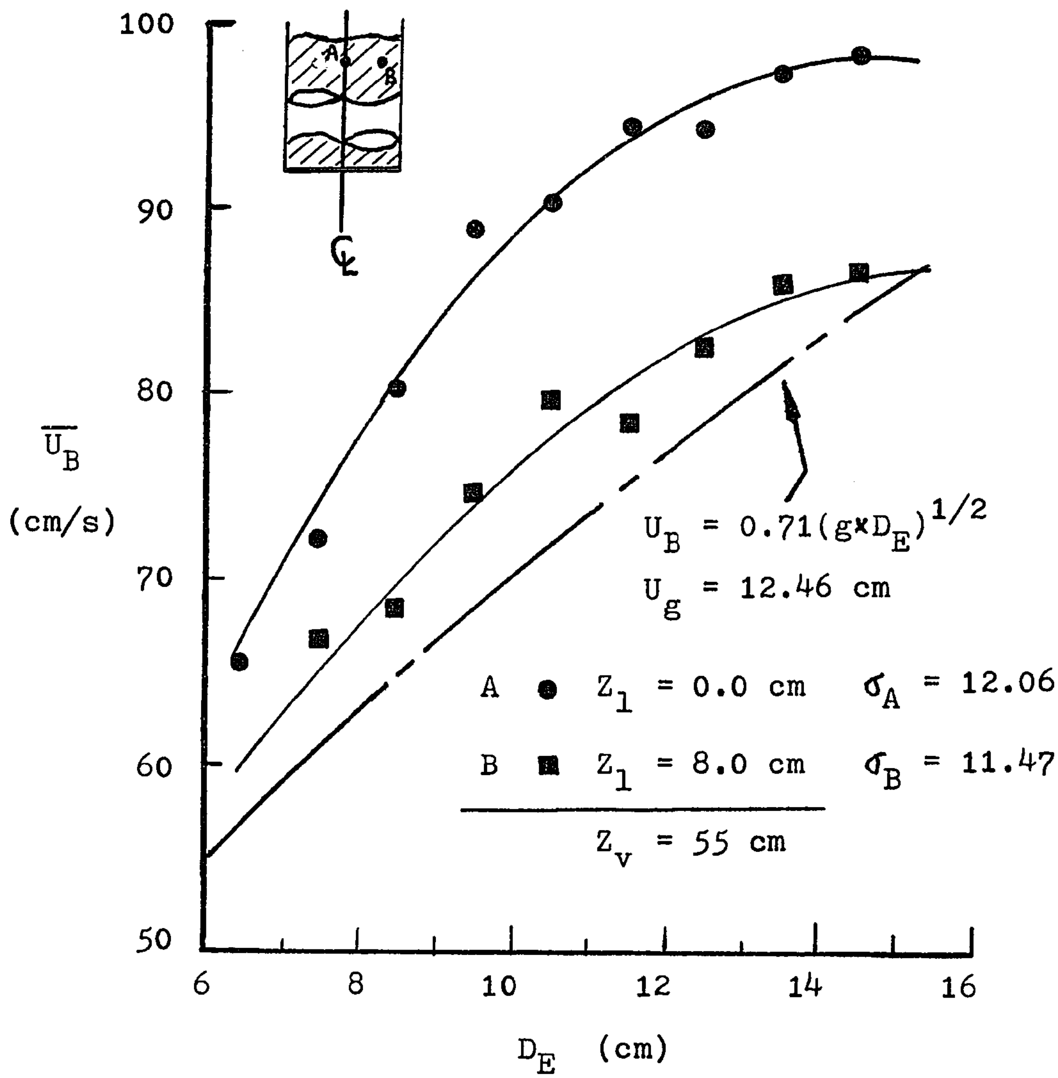

Figure 27. Variation of mean bubble velocity with size and position at the top of the fluidized bed.

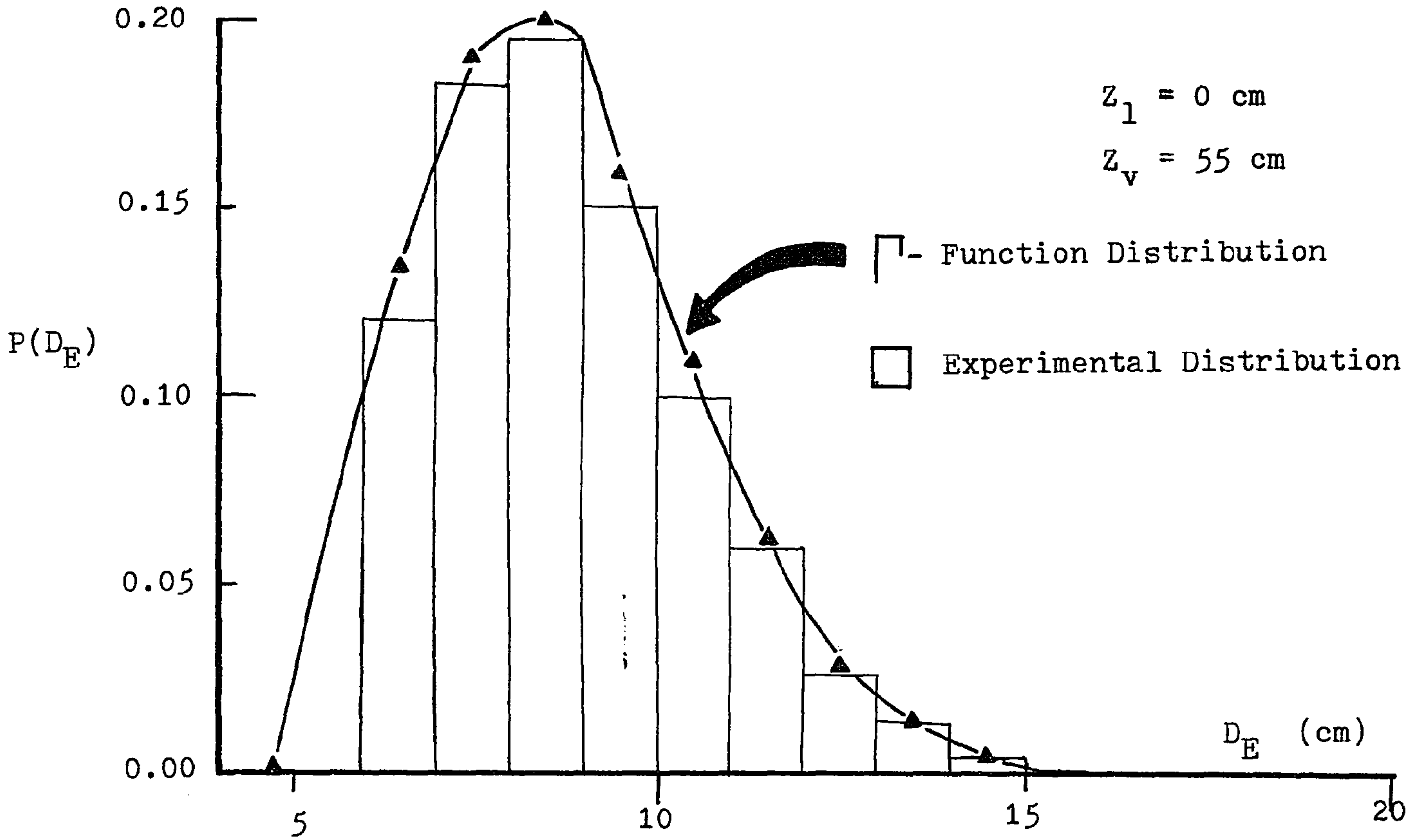

Figure 28. Typical measured bubble size distribution with gamma-function distribution analytical fit.

defined in terms of the number of bubbles for a particular size divided by the total number of measured bubbles. The probe is only capable to detect the bubbles with its traverse axes longer than 6 cm. Thus, the size distribution for bubbles in the bed is naturally truncated. In order to adjust the mean of the truncated bubble size distribution, the truncated error δ is introduced. The truncated gamma function distribution,

$$P\,(d_e) = \frac{\beta^{\alpha}}{\Gamma(\alpha)}\,\mathrm{EXP}\,(-\beta d_e)\cdot(d_e)^{-1} \tag{37}$$

where

$$\alpha = \frac{(\bar{d}_e)^2}{\sigma^2_{d_e}} \tag{38}$$

$$\beta = \frac{\bar{d}_e}{\sigma^2_{d_e}} \tag{39}$$

$$d_e = D_E - \delta \tag{40}$$

provides an excellent fit to the data, as shown in Figure 28 and Figure 29.

Figure 30 and Figure 31 show the variation of size distribution with the vertical level above the gas distributor. The bubble size increasing with the level in the

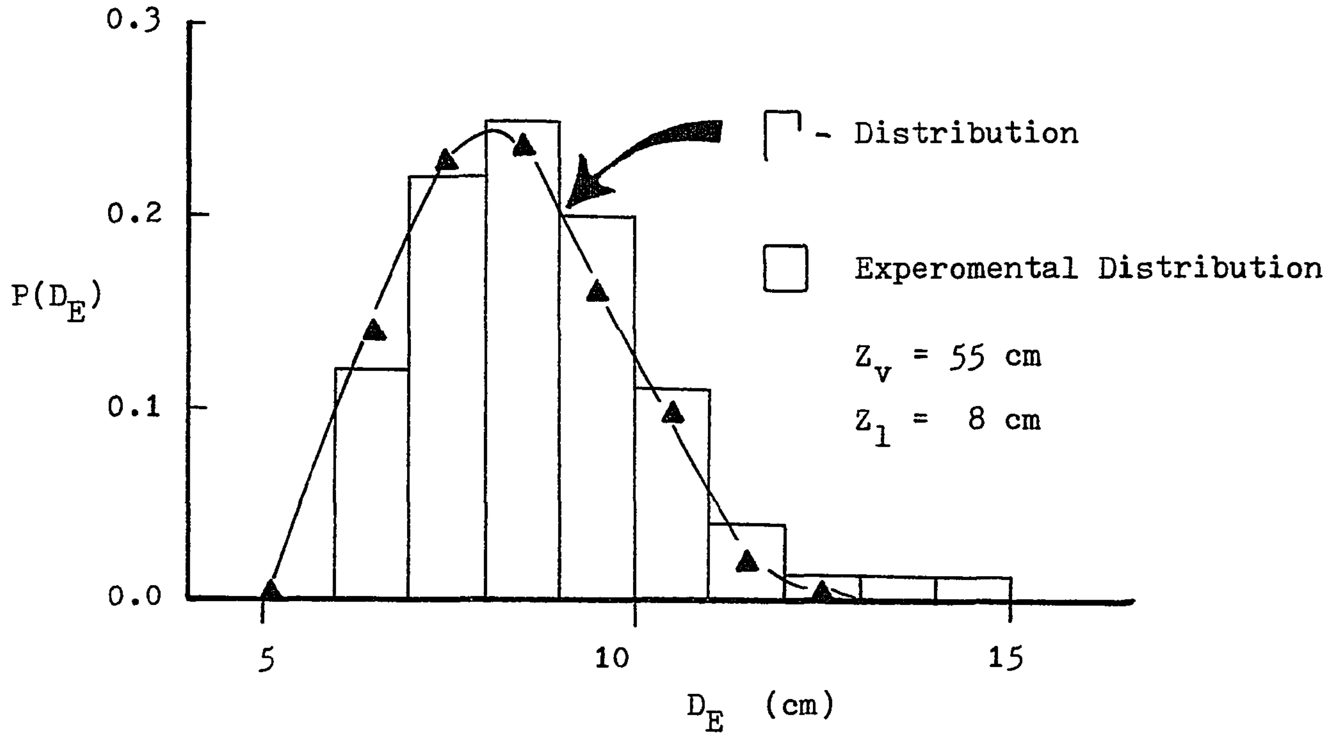

Figure 29. Typical bubble size distribution reported by the probe together with gamma function distribution fit.

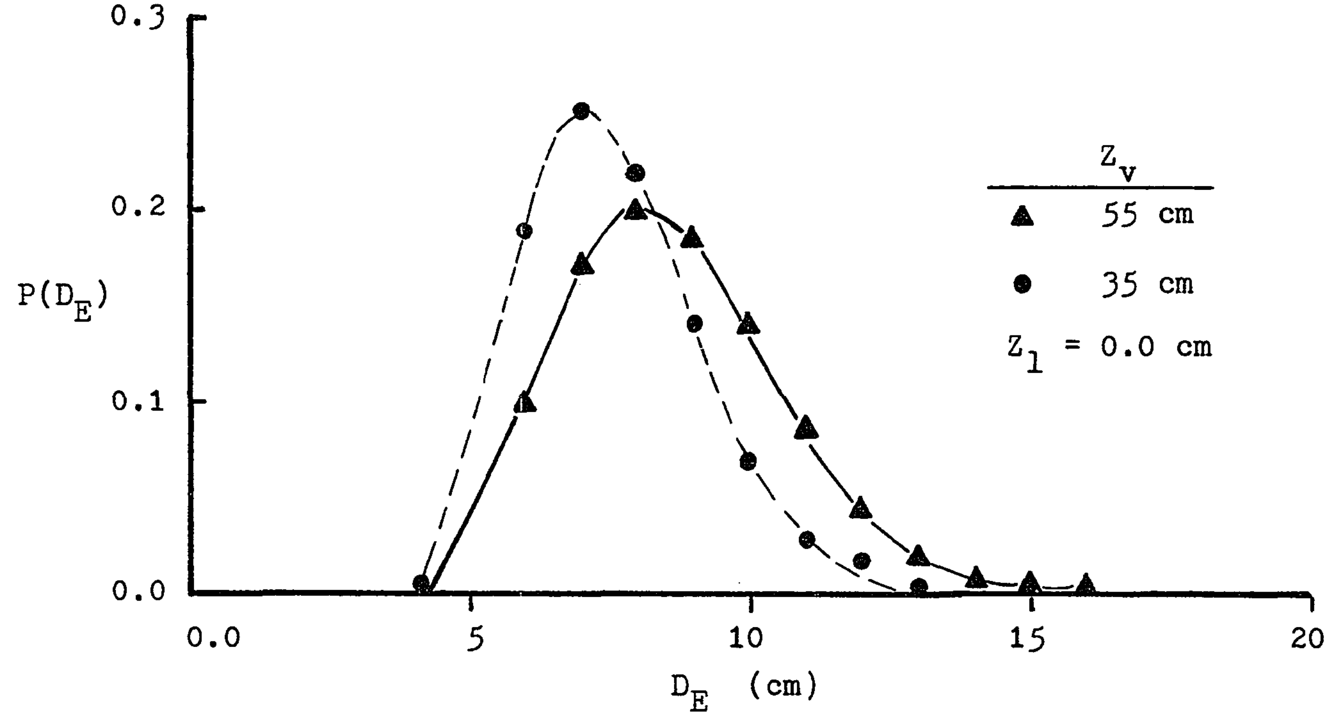

Figure 30. Variation of the gamma function bubble size distribution with vertical level in the fluidized bed on the bed centreline.

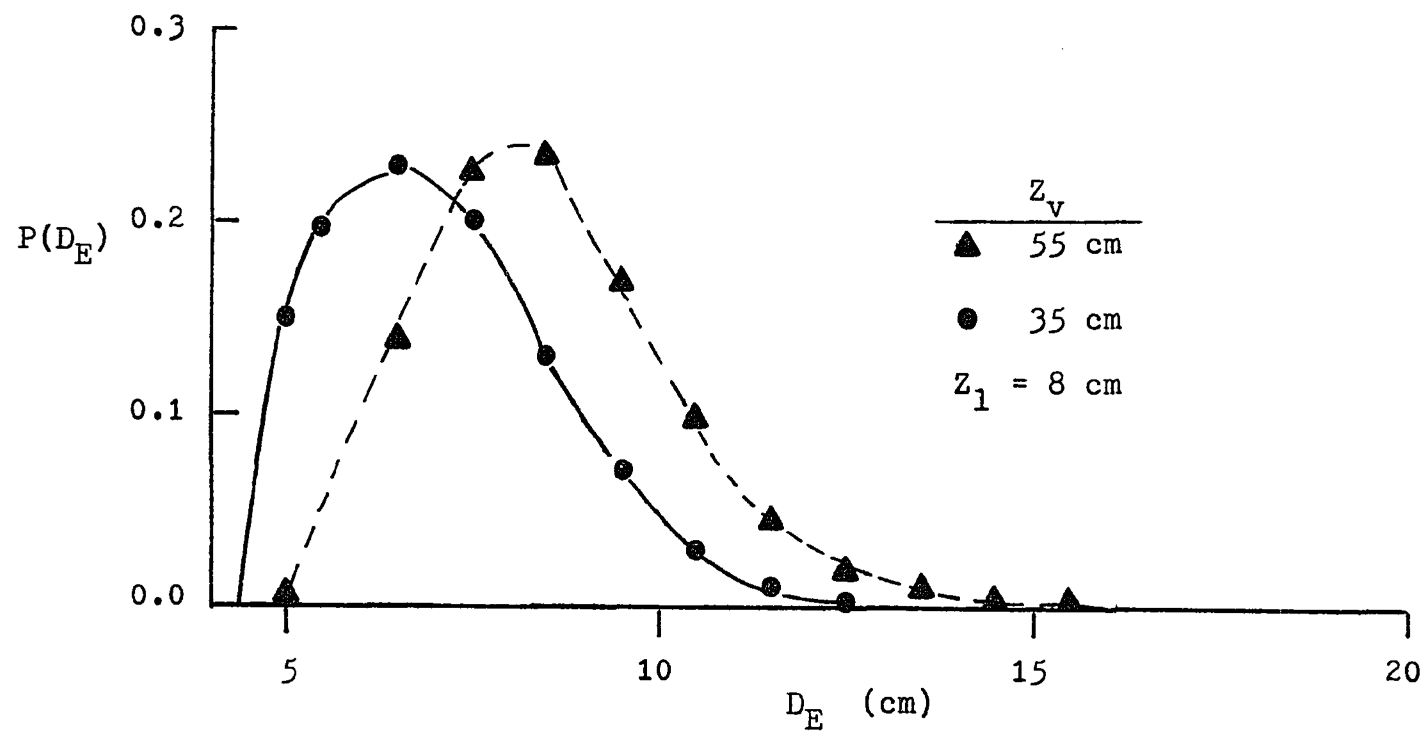

Figure 31. Variation of the gamma function bubble size distribution with vertical level in the fluidized bed at 8 cm distance from bed centreline.

bed is clearly seen. Figure 32 and 33 show the variation of size distribution with lateral position at the top and the middle of the bed respectively.

Figure 34 shows the variation of the mean bubble size distribution in the bed at different positions. The influence of bubble coalescence is obvious.

The changes in the size distribution variance with position in the bed is shown in Figure 35.

Bubble Frequency Distribution

Figure 36 shows the variation of bubble frequency distribution with the position in the bed. The sawtooth type of bubble frequency distribution at the lower part of the bed indicates that the design of the gas distributor plays a major role here. However, the bubbles rise more uniformly at lower level of the bed. The observed non-uniformity and decrement of the bubble development at greater heights is due to the bubble coalescence. The variation of bubble frequency with gas flow rate is shown in Figure 37. These data also show gas bubbles do increase their frequency with gas flow rate as a result of the increment of the formation of bubbles. The result of the different conditions of friction within the fluidized media and between the media and the wall might favor the bubble formation in the zone near the wall.

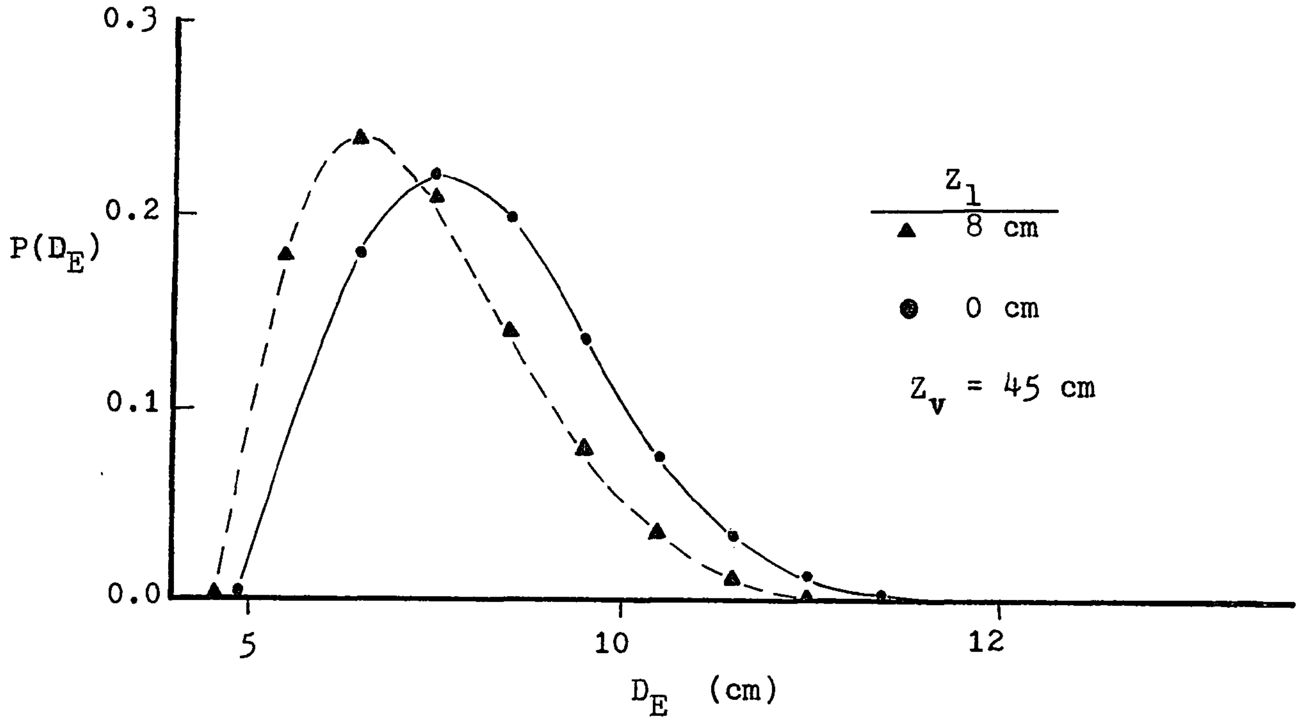

Figure 32. Variation of size distribution with lateral position at the top of the fluidized bed.

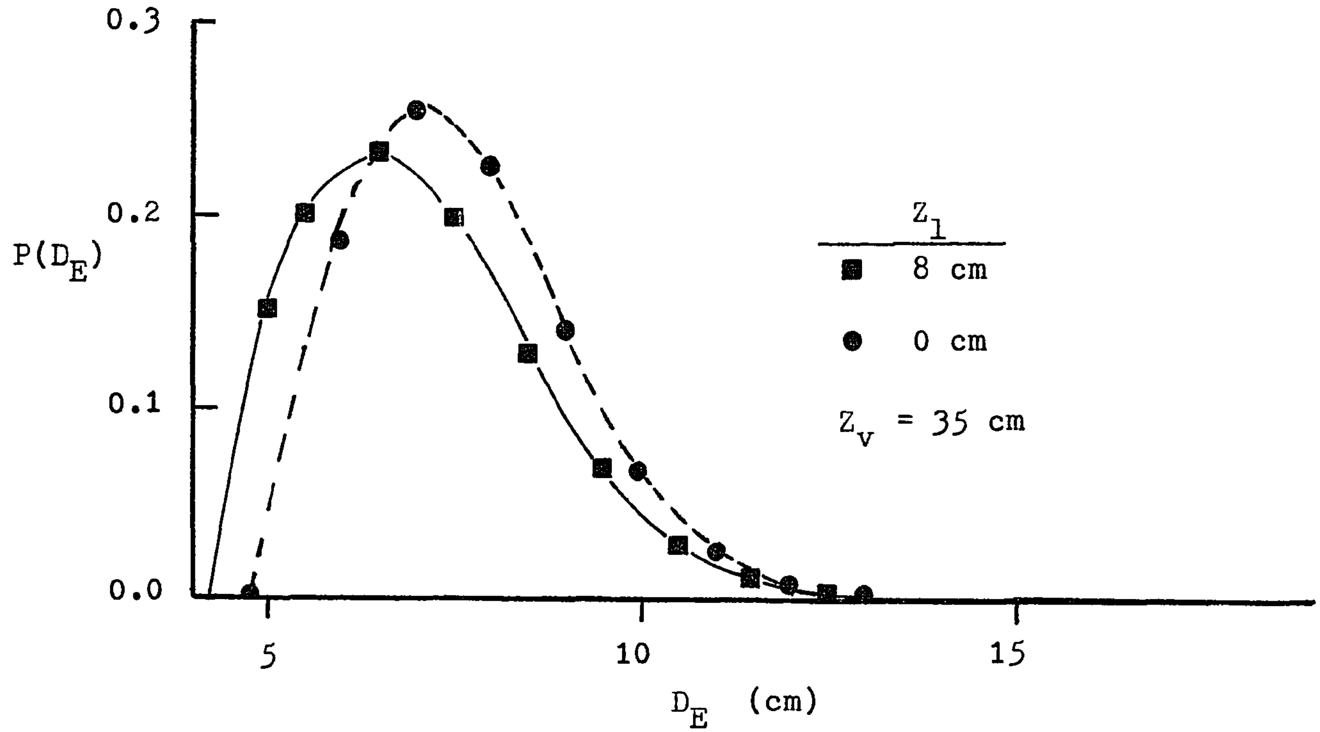

Figure 33. Variation of size distribution with lateral position at the middle of the fluidized bed.

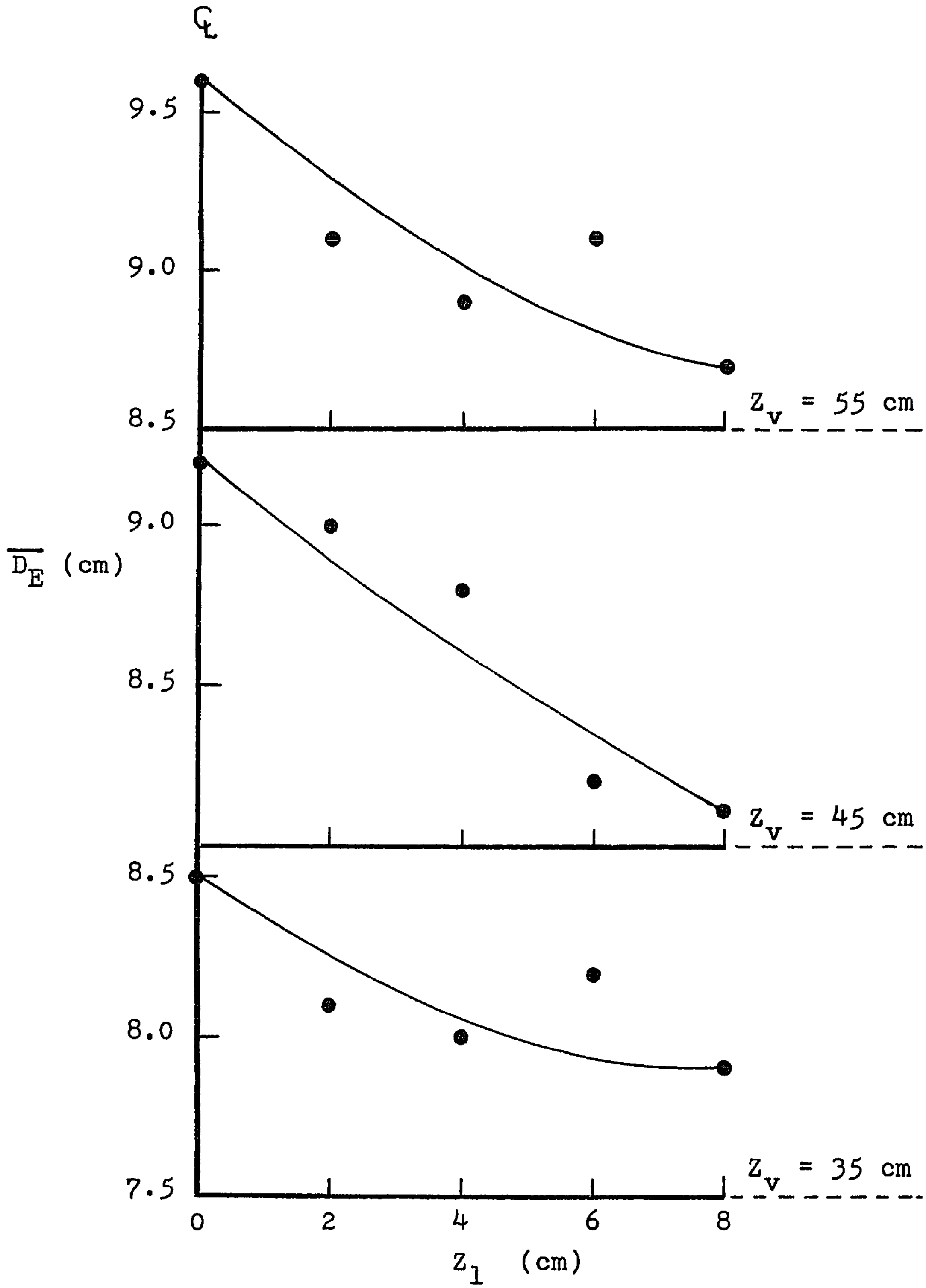

Figure 34. Variation of mean bubble size distribution in the bed at different position.

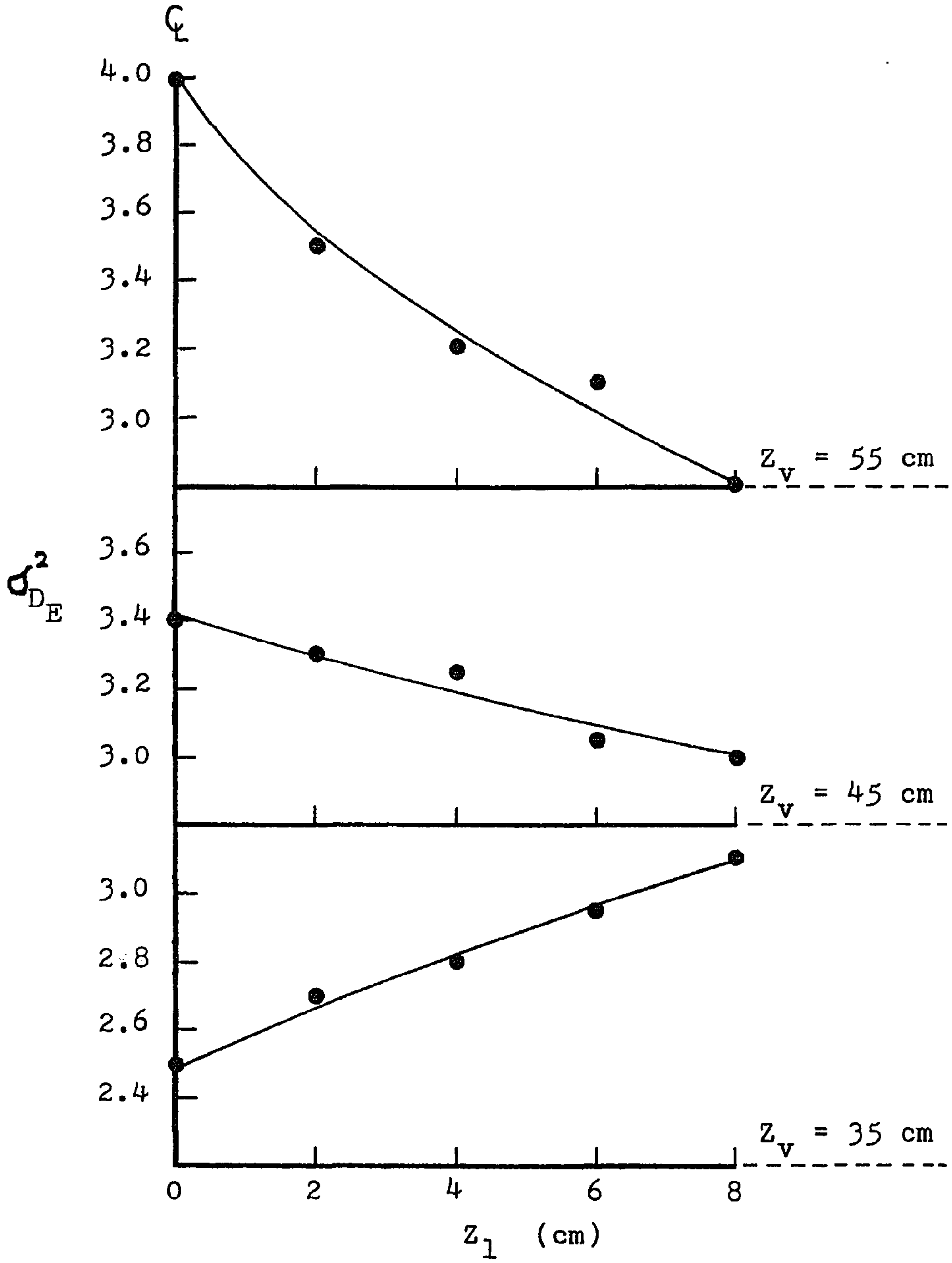

Figure 35. The changes in the size distribution variance with position in the fluidized bed.

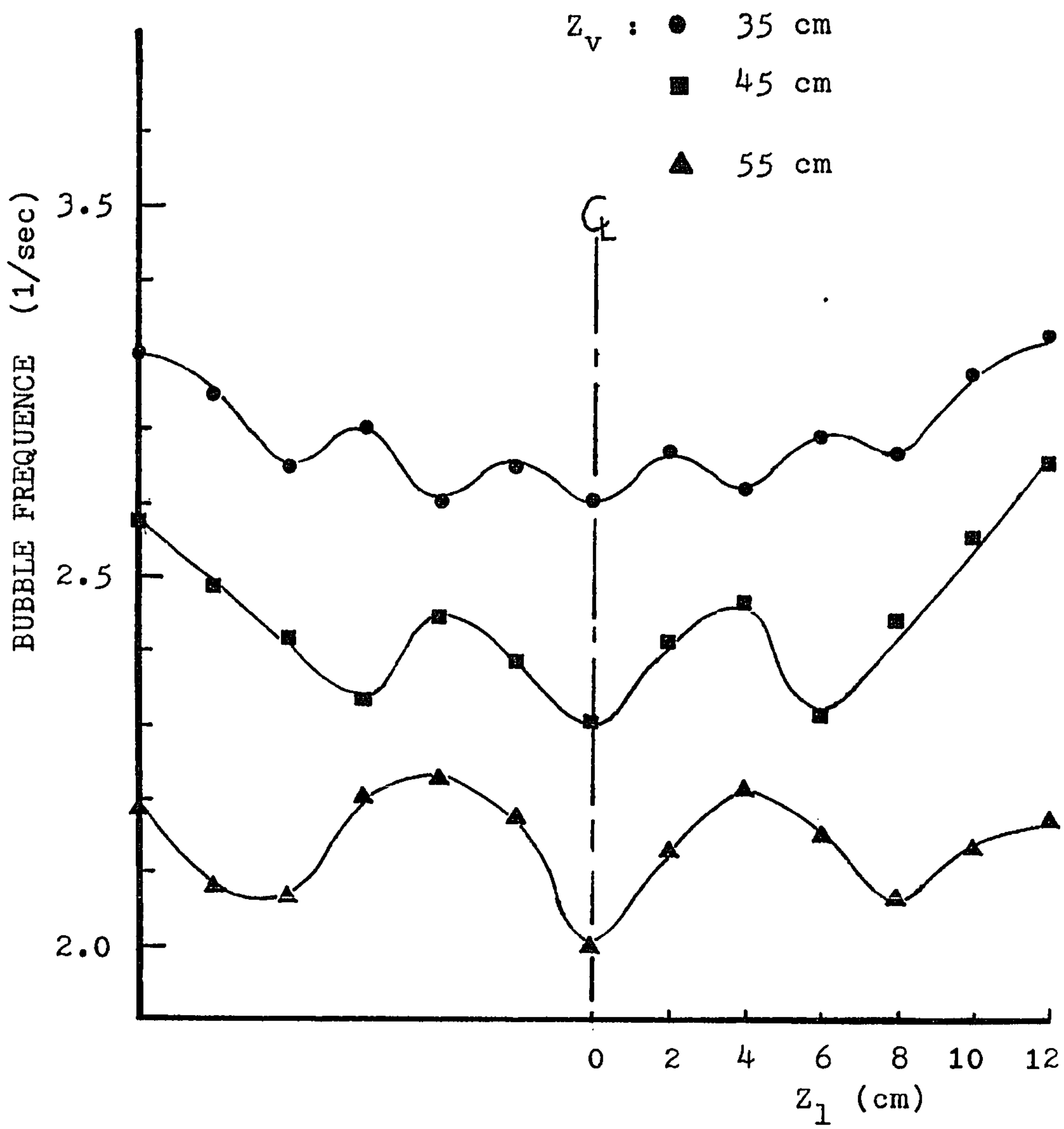

Figure 36. Variation of bubble frequency with position in the fluidized bed.

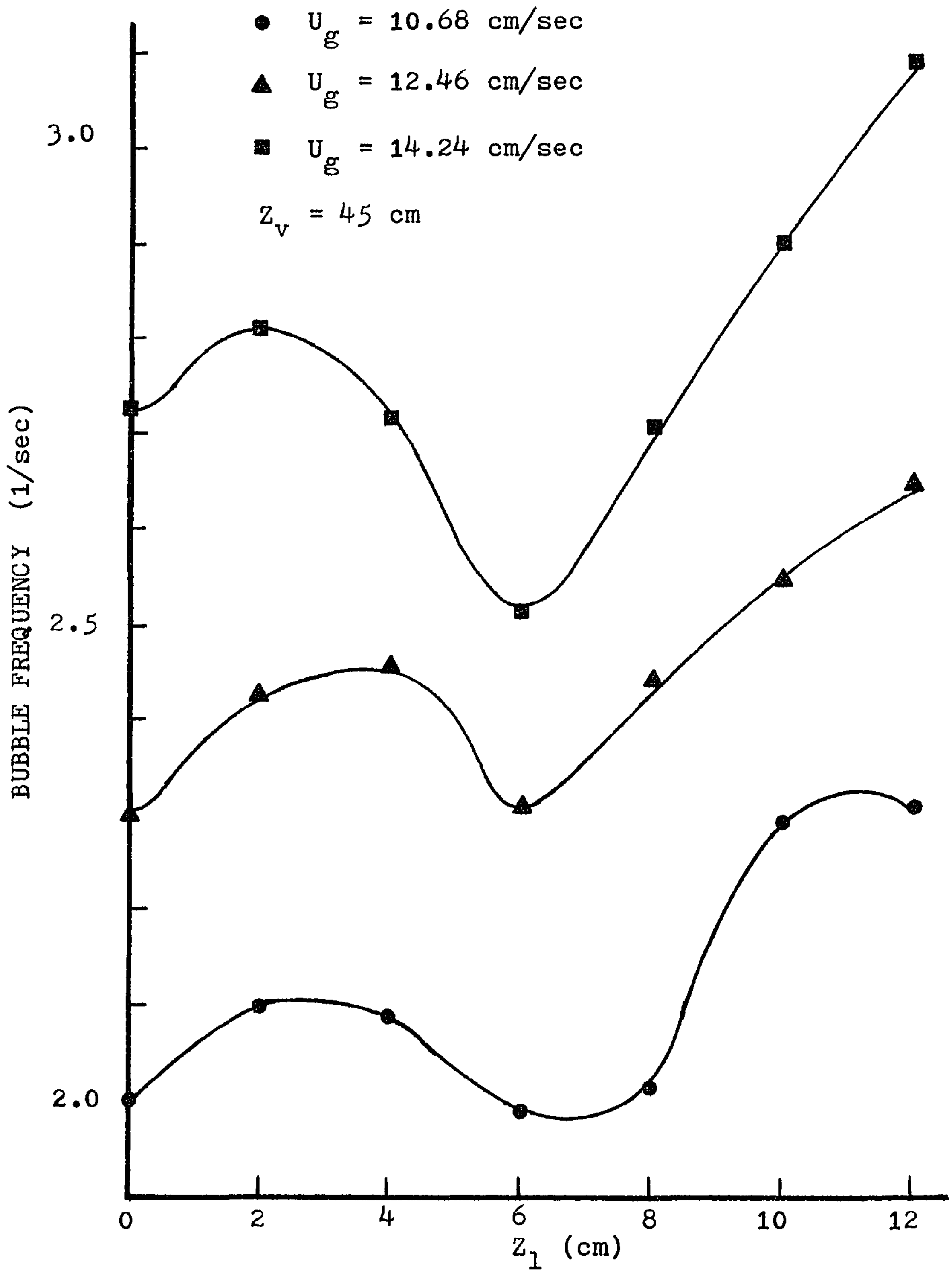

Figure 37. Variation of bubble frequency with superficial gas velocity and lateral position in the fluidized bed.

Chapter VI

CONCLUSIONS

A novel optical probe system has been developed and used for on-line monitoring of bubble characteristics in a three-dimensional gas fluidized bed. The optical probe system which measures the local bubble characteristics and accepts for measurement only those bubbles whose central axes are coincident with the vertical probe axis is capable of resolving fine details of bubble flows in freely bubbling fluidized beds. Four non-inverting comparators with hysteresis has been used to improve the noise immunity of the system. By means of these experiments and application of statistical evaluation methods, the bubble size distribution, shape, and velocity can be determined.

A 96 liter rectangular fluidized bed was used, containing glass beads with a size fraction of 355μ - 250μ. Air was the fluidizing medium with gas velocities ranging from 1.2 U_{mf} to 2.0 U_{mf}. The probe position was varied from 35 cm to 55 cm above the distributor, and 0 to 8 cm from the bed centreline. At moderate gas velocities, the bubble size distribution can be approximated by gamma function distribution. The bubble size distributions vary not only with vertical position in the fluidized bed but also vary with lateral position in the bed. It was also found that the Davies-Taylor Equation for bubble velocity was inadequate to fit the data, since the velocity varied significantly with position in the bed.

Motion pictures were also taken for a two-dimensional bed to obtain qualitative information on bubble characteristics. In agreement with the limited available results of other authors, this information shows that the basic bubble shapes and bubbles do increase in size with particle size, position height, and gas velocity. The bubble increases its size with the height in the bed by coalescence and maintains a maximum stable size by splitting.

Chapter VII

RECOMMENDATIONS

Further effort should be devoted to study the phenomena of high gas velocity fluidization with fine particles. Thus the continuous operation of a 3-D bed should be set up in order to recycle the particles.

As indicated in the qualitative observation section, the probe would be too large in dimension for small bubble measurement in a fluidized bed with fine particles. Thus, an immediate task would be the further miniaturization of the probe. This may also be necessary for minimizing local disturbance in the bed as pointed out in a recent paper by Rowe and Masson[36]. Optical fiber would be suggested to replace LED and photo-cell to further reduce the probe dimension.

Also the Intel 8085 microprocessor has the capability of communicating with a teletype. If the interface between Intel 8085 microprocessor and Univac 90/80-4 and a teletype are added, the data processing system will be improved to be a fast real-time data processing system.

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APPENDIX A

COMPUTER AIDED CALCULATION OF BUBBLE CHARACTERISTICS

```
C   THOMAS TAI-PAI CHU
C   CHE 790 DOCTORAL RESEARCH AND DISSERTATION
C
C   BUBBLE CHARACTERISTICS CALCULATION
C
C   PS1:LOWER LIMIT OF PARTICLE SIZE RANGE
C   PS2:UPPER LIMIT OF PARTICLE SIZE RANGE
C   CT1:NUMBER OF TIME INTERVALS MEASURED
   A     FOR AXIAL LENGTH CALCULATION
C   CT2:NUMBER OF TIME INTERVALS MEASURED
C   PS1:LOWER LIMIT OF PARTICLE SIZE RANGE
C   PS2:UPPER LIMIT OF PARTICLE SIZE RANGE
C   CT1:NUMBER OF TIME INTERVALS MEASURED
   A     FOR AXIAL LENGTH CALCULATION
C   CT2:NUMBER OF TIME INTERVALS MEASURED
   A     FOR CHORD LENGTH CALCULATION
C   CDT1:NUMBER OF TIME INTERVALS MEASURED
   A      FOR VELOCITY CALCULATION
C   CDT2:NUMBER OF TIME INTERVALS MEASURED
   A      FOR FRONTAL CURVATURE CALCULATION
C   NDB:NUMBER OF DIMENSION OF FLUISIZED BED
C   LP:LATERAL POSITION OF PROBE WITHIN FLUIDIZED BED
C   H:VERTICAL POSITION OF PROBE WITHIN FLUIDIZED BED
C   FR:SUPERFICIAL GAS VELOCITY
C   NDATA:NUMBER OF MEASUREMENTS
C   UB:BUBBLE VELOCITY
C   AL:BUBBLE VERTICAL AXIAL LENGTH
C   B:BUBBLE VERTICAL CHORD LENGTH
C   FD:HEIGHT DIFFERENCE BETWEEN TWO POINTS ON
   A    BUBBLE FRONTAL SURFACE DETECTED BY PROBES
C   RF:RADIUS OF BUBBLE FRONTAL SURFACE
C   DF:DIAMETER OF BUBBLE FRONTAL SURFACE
C   WD:HEIGHT DIFFERENCE BETWEEN TWO POINTS ON
   A    BUBBLE WAKE SURFACE DETECTED BY PROBES
C   RW:RADIUS OF BUBBLE WAKE SURFACE
C   HW:HEIGHT OF BUBBLE WAKE
C   RR:RADIUS OF HORIZONTAL BUBBLE CUTTING SURFACE
C   VB:BUBBLE VOLUME
C   DE:EQUIVALENT BUBBLE DIAMETER
C
    INTEGER PS1,PS2,CT1,CT2,CDT1,CDT2,H
    READ(1,*)NDB,LP,H,FR,PS1,PS2,NDATA
    WRITE(2,101)NDB,LP,H
101 FORMAT(14X,I1,'-D BED',5X,'PROBE POSITION=(',I2,
   A'CM,',I2,'CM)')
    WRITE(2,102)FR,PS1,PS2
102 FORMAT(/,3X,'SUPERFICIAL GAS VELOCITY=',F5.2,
   A'CM/SEC',3X,'PARTICLE SIZE:',I3,'-',I3)
    WRITE(2,103)
103 FORMAT(//,5X,'UB',7X,'AL',6X,'RF',6X,'RR',6X,'RW',
```

```
   A5X,'VB',7X,'DE',4X,'SHAPE',/)
    DO 19 II=1,NDATA
    READ(1,*)CT1,CT2,CDT1,CDT2
C   T:TIME INTERVAL(SEC)
    T=0.002
    UB=3.0/CDT1/T
    AL=CT1*T*UB
    B=CT2*T*UB
    FD=CDT2*T*UB
C   FD:HEIGHT DIFFERENCE BETWEEN TWO POINTS
   A    ON FRONTAL CURVE DETECTED BY PROBES
C   ...BY TRIAL AND ERROR METHOD TO DETERMINE
   A    THE SUPERFICIAL BUBBLE RADIUS...
C   R1:INITIAL TRIAL VALUE FOR BUBBLE FRONTAL
   A    SURFACE RADIUS
C   DR1:LARGER INCREMENT
C   DR2:SMALL INCREMENT
    R1=((3.0-FD)**2+3*3)**0.5
    DR1=R1*0.1
    DR2=R1*0.01
C   ...USING LARGER INCREMENT TO SEARCH RF...
    DO 1 I=1,30
    RF=R1+DR1*I
    RF1=(RF**2-3*3)**0.5+FD
    X=ABS(RF1-RF)
    IF(X.LE.0.001)GO TO 4
C   ...CHECKING FOR CONVERGENCE...
    IF(RF1.GT.RF)GO TO 2
1   CONTINUE
2   RF2=RF-DR1
C   ...USING SMALL INCREMENT TO SEARCH RF...
    DO 3 J=1,10
    RF=RF2+DR2*J
    RF1=(RF**2-3*3)**0.5+FD
    X=ABS(RF1-RF)
    IF(X.LE.0.001)GO TO 4
3   CONTINUE
4   DF=RF*2
C   ...BY TRIAL AND ERROR METHOD TO DETERMINE
   A    THE WAKE SURFACE RADIUS...............
C   WD:HEIGHT DIFFERENCE BETWEEN TWO POINTS
   A    ON WAKE SURFACE DETECTED BY PROBES
C   R2:INITIAL TRIAL VALUE FOR WAKE SURFACE
   A    RADIUS DETERMINATION
    WD=ABS(FD+B-AL)
    IF(WD.LE.0.001)GO TO 12
    R2=((3.0-WD)**2+3*3)**0.5
    DR3=R2*0.1
    DR4=R2*0.01
C   ...USING LARGER INCREMENT TO SEARCH RW...
```

```
      DO 5 K=1,30
      RW=R2+DR3*K
      RW1=(RW**2-3*3)**0.5+WD
      Y=ABS(RW1-RW)
      IF(Y.LE.0.001)GO TO 8
C     ...CHECKING FOR CONVERGENCE...
      IF(RW1.GT.RW)GO TO 6
    5 CONTINUE
    6 RW2=RW-DR3
C     ...USING SMALL INCREMENT TO SEARCH RW...
      DO 7 L=1,10
      RW=RW2+DR4*L
      RW1=(RW**2-3*3)**0.5+WD
      Y=ABS(RW1-RW)
      IF(Y.LE.0.001)GO TO 8
    7 CONTINUE
    8 IF(AL.GE.DF)GO TO 16
      RB=RF
C     DB:SUPERFICIAL BUBBLE DIAMETER
      DB=DF
      IF(AL-RB)9,10,11
C     ...IF BUBBLE AXIAL LENGTH IS LESS THAN
     A    THE SUPERFICIAL BUBBLE RADIUS.....
C     HW:HEIGHT OF BUBBLE WAKE
C     SS:HEIGHT OF BUBBLE
    9 HW=(2*RB*AL-AL**2)/2/(RW-RB+AL)
      RR=(2*RW*HW-HW**2)**0.5
      SS=AL+HW
C     ...IF BUBBLE HEIGHT LESS THAN BUBBLE RADIUS
     A    AND WITH DENTED BOTTOM........
      IF(SS.GT.RB)GO TO 10
      VB1=3.1416*(AL+HW)*(3*RR**2+(AL+HW)**2)/6
      VB2=3.1416*HW*(3*RR**2+HW**2)/6
      VB=VB1-VB2
      DE=(6*VB/3.1416)**(1./3)
      WRITE(2,105)UB,AL,RF,RR,RW,VB,DE
  105 FORMAT(1X,5F8.2,F8.1,F8.2,3X,'S.L.D.')
      GO TO 19
C     ...IF BUBBLE HEIGHT EQUALS TO BUBBLE RADIUS
     A    AND AXIAL LENGTH LESS THAN BUBBLE RADIUS....
   10 V1=3.1416*DB**3/6
      V2=3.1416*HW*(3*RR**2+HW**2)/6
      VB=V1-V2
      DE=(6*VB/3.1416)**(1./3)
      WRITE(2,106)UB,AL,RF,RR,RW,VB,DE
  106 FORMAT(1X,5F8.2,F8.1,F8.2,3X,'H.S.D.')
      GO TO 19
C     ...IF BOTH BUBBLE HEIGHT AND AXIAL
     A    LENGTH ARE GREATER THAN BUBBLE RADIUS....
   11 V1=3.1416*(DB**3)/6
```

```
      S=(RB+RW+(AL-RB+RW))/2
      P=((S-RB)*(S-RW)*(S-AL+RB-RW)/S)**0.5
      A1=ATAN(P/(S-RW))*2
      RR=RB*SIN(A1)
      H1=RB*COS(A1)-AL+RB
      V2=3.1416*H1*(3*RR*RR+H1**2)/6
      H2=RB*(1-COS(A1))
      V3=3.1416*H2*(3*RR*RR+H2**2)/6
      VB=V1-V2-V3
      DE=(6*VB/3.1416)**(1./3)
      WRITE(2,107)UB,AL,RF,RR,RW,VB,DE
107   FORMAT(1X,5F8.2,F8.1,F8.2,3X,'S.G.D.')
      GO TO 19
C     ...FOR FLAT BOTTOM BUBBLE AND AXIAL LENGTH
     A   EQUALS TO BUBBLE HEIGHT.....
12    IF(AL.GE.DF)GO TO 17
      DB=DF
      RB=RF
C     ...FOR BUBBLE HEIGHT LESS THAN SUPERFICIAL
     A   BUBBLE RADIUS........
      IF(AL-RB)13,14,15
13    RR=(RB**2-(RB-AL)**2)**0.5
      VB=3.1416*AL*(3*RR**2+AL**2)/6
      DE=(6*VB/3.116)**(1./3)
      WRITE(2,108)UB,AL,RF,RR,VB,DE
108   FORMAT(1X,4F8.2,5X,'--',1X,F8.1,F8.2,3X,'S.L.')
      GO TO 19
C     ...IF BUBBLE HEIGHT EQUALS TO SUPERFICIAL
     A   BUBBLE RADIUS.......
14    RR=RF
      VB=3.1416*DB**3/12
      DE=(6*VB/3.1416)**(1./3)
      WRITE(2,109)UB,AL,RF,RR,VB,DE
109   FORMAT(1X,4F8.2,5X,'--',1X,F8.1,F8.2,3X,'H.S.')
      GO TO 19
C     ...IF BUBBLE HEIGHT IS GREATER THAN
     A   THE SUPERFICIAL BUBBLE RADIUS.......
15    RR=(RB**2-(AL-RB)**2)**0.5
      VB1=3.1416*DB**3/6
      VB2=3.1416*(DB-AL)*(3*RR**2+(DB-AL)**2)/6
      VB=VB1-VB2
      DE=(6*VB/3.1416)**(1./3)
      WRITE(2,110)UB,AL,RF,RR,VB,DE
110   FORMAT(1X,4F8.2,5X,'--',1X,F8.1,F8.2,3X,'S.G.')
      GO TO 19
C     ...FOR PARABOLIC BUBBLE...
C     ...PARABOLIC BUBBLE WITH DENTED WAKE...
16    C=3*3/FD
      C1=(C-2*RW)**2-4*C*AL
      IF(C1.LT.0.0)GO TO 18
```

```
      HW=(RW*2-C-((C-RW*2)**2-4*C*AL)**0.5)/2
      RR=(C*(AL+HW))**0.5
      V4=3.1416*HW*(3*RR*RR+HW**2)/6
      V5=C*3.1416*(AL+HW)**2/2
      VB=V5-V4
      DE=(6*VB/3.1416)**(1./3)
      WRITE(2,111)UB,AL,RF,RR,RW,VB,DE
111   FORMAT(1X,5F8.2,F8.1,F8.2,3X,'P.C.')
      GO TO 19
C     ...PARABOLIC BUBBLE WITH FLAT BOTTOM...
17    C=3*3/FD
      RR=(C*AL)**0.5
      VB=C*3.1416*AL**2/2
      DE=(6*VB/3.1416)**(1./3)
      WRITE(2,112)UB,AL,RF,RR,VB,DE
112   FORMAT(1X,4F8.2,5X,'--',1X,F8.1,F8.2,3X,'PAR.')
      GO TO 19
C     ...PARABOLIC BUBBLE WITH A PARTIAL DENTED WAKE...
18    RR=(RW+3.)/2
      HW=RW-(RW**2-RR**2)**0.5
      V6=3.1416*HW*(3*RR*RR+HW**2)/6
      V7=3.1416*C*(AL+HW)**2/2
      VB=V7-V6
      DE=(6*VB/3.1416)**(1./3)
      WRITE(2,113)UB,AL,RF,RR,RW,VB,DE
113   FORMAT(1X,5F8.2,F8.1,F8.2,3X,'P.C.')
19    CONTINUE
      STOP
      END
```

APPENDIX B

SOFTWARE SIGNAL DISCRIMINATOR AND PROCESSOR

```
FILE: FLUID:GCJ          HEWLETT-PACKARD: 8085 Assembler

LOCATION OBJECT CODE LINE     SOURCE LINE

                                          "8085"
             <2000>            EPSILLON   EQU          2000H
             <2001>            DISPCNT    EQU          2001H
             <2002>            DATA       EQU          2002H
             <2004>            FREQDAT    EQU          2004H
             <20CF>            INTER      EQU          20CFH
             <9800>            RAM        EQU          9800H
             <A003>            STA1       EQU          0A003H
             <A803>            STA2       EQU          0A803H
             <B003>            STA3       EQU          0B003H
             <B803>            STA4       EQU          0B803H
             <A000>            VEL        EQU          0A000H
             <A001>            DIA        EQU          0A001H
             <A002>            PRB1       EQU          0A002H
             <A800>            PRB3       EQU          0A800H
             <A801>            OFFSET     EQU          0A801H
             <A802>            CURVE      EQU          0A802H
             <B000>            FREQCNT    EQU          0B000H
             <B800>            TIMER1     EQU          0B800H
             <B802>            CLOCK      EQU          0B802H

    0000 AF                               XRA A        ;SET A TO 0

    0001 21A003                           LXI H,STA1   ;PROG TIMER#1
    0004 3E11                             MVI A,11H
    0006 77                               MOV M,A
    0007 3E71                             MVI A,71H    ;DOUBLE BYTE
    0009 77                               MOV M,A
    000A 3EB1                             MVI A,0B1H   ;DOUBLE BYTE
    000C 77                               MOV M,A

    000D 21A803                           LXI H,STA2   ;PROG TIMER#2
    0010 3E31                             MVI A,31H    ;DOUBLE BYTE
    0012 77                               MOV M,A
    0013 3E51                             MVI A,51H
    0015 77                               MOV M,A
    0016 3E91                             MVI A,91H
    0018 77                               MOV M,A

    0019 21B003                           LXI H,STA3   ;PROG FREQ CNTR
    001C 3E31                             MVI A,31H    ;DOUBLE BYTE
    001E 77                               MOV M,A
    001F 3E71                             MVI A,71H    ;DOUBLE BYTE
    0021 77                               MOV M,A
    0022 3EB1                             MVI A,0B1H   ;DOUBLE BYTE
    0024 77                               MOV M,A
```

```
0025 21B803                LXI H,STA4       ;PROG TIMERS
0028 3E37                  MVI A,37H        ;DOUBLE BYTE
002A 77                    MOV M,A
002B 3E77                  MVI A,77H        ;DOUBLE BYTE
002D 77                    MOV M,A
002E 3EB1                  MVI A,0B1H       ;DOUBLE BYTE
0030 77                    MOV M,A

0031 21B800                LXI H,TIMER1     ;PROG CLK TIMER
0034 113072                LXI D,3072H      ;2 MSEC. CLK
0037 73                    MOV M,E
0038 72                    MOV M,D
0039 23                    INX H
003A 110500                LXI D,500H       ;1 SEC. CLK
003D 73                    MOV M,E
003E 72                    MOV M,D

003F 219800                LXI H,RAM        ;CLR MEMORY
0042 AF                    XRA A            ;SET A TO 0
0043 2D          ERASE     DCR L
0044 77                    MOV M,A
0045 C20043                JNZ ERASE

0048 222002                SHLD DATA        ;LD DATA VECT
004B AF                    XRA A            ;SET A TO 0
004C 322001                STA DISPCNT

004F 3EC3                  MVI A,0C3H       ;LD INTR VECT
0051 3220CE                STA 20CEH
0054 210064                LXI H,START
0057 2220CF                SHLD INTER

005A 3120C2                LXI SP,20C2H     ;SET STK PNTR

005D 3E1B                  MVI A,1BH        ;DIS 5.5 & 6.5
005F 30                    SIM
0060 FB                    EI

0061 C30061      WAIT      JMP WAIT

0064 AF          START     XRA A            ;SET A TO 0
0065 CD036E                CALL 36EH        ;DISP '00'

0068 11FFFF                LXI D,0FFFFH     ;DELAY FOR INTR
006B CD05F1                CALL 5F1H

006E 3E99                  MVI A,99H        ;RES FREQ CNTRS
0070 21B000                LXI H,FREQCNT
0073 77                    MOV M,A
```

```
0074 77                      MOV M,A
0075 23                      INX H
0076 77                      MOV M,A
0077 77                      MOV M,A
0078 23                      INX H
0079 77                      MOV M,A
007A 77                      MOV M,A

007B 21B802                  LXI H,CLOCK      ;RES SEC CLK
007E 77                      MOV M,A
007F 77                      MOV M,A

0080 210145                  LXI H,EXIT       ;SET INTR VECT
0083 2220CF                  SHLD INTER

0086 3E1B                    MVI A,1BH        ;DIS 5.5 & 6.5
0088 30                      SIM
0089 FB                      EI

008A 3E99        RESTART     MVI A,99H        ;RES TIMER #1
008C 21A000                  LXI H,VEL
008F 77                      MOV M,A
0090 23                      INX H
0091 77                      MOV M,A
0092 77                      MOV M,A
0093 23                      INX H
0094 77                      MOV M,A
0095 77                      MOV M,A

0096 21A800                  LXI H,PRB3       ;RES TIMER#2
0099 77                      MOV M,A
009A 77                      MOV M,A
009B 23                      INX H
009C 77                      MOV M,A
009D 23                      INX H
009E 77                      MOV M,A

009F 21008A                  LXI H,RESTART    ;LD RESTART PNTR

00A2 DB00        CHK1        IN 00H           ;CHK FOR 4
00A4 E60F                    ANI 0FH
00A6 FE00                    CPI 00H
00A8 CA00A2                  JZ CHK1
00AB FE01                    CPI 01
00AD CA00B1                  JZ CHK2
00B0 E9                      PCHL

00B1 DB00        CHK2        IN 00H           ;CHK FOR 4 & 2
00B3 E60F                    ANI 0FH
00B5 FE01                    CPI 01H
00B7 CA00B1                  JZ CHK2
00BA FE03                    CPI 03H
00BC CA00C0                  JZ CHK3
```

```
00BF E9                              PCHL

00C0 DB00        CHK3                IN 00H              ;CHK FOR ALL
00C2 E60F                            ANI 0FH
00C4 FE0F                            CPI 0FH
00C6 CA00D1                          JZ CHK4
00C9 E603                            ANI 03H
00CB FE03                            CPI 03H
00CD CA00C0                          JZ CHK3
00D0 E9                              PCHL

00D1 DB00        CHK4                IN 00H              ;CHK FOR 1,2 & 3
00D3 E60F                            ANI 0FH
00D5 FE0F                            CPI 0FH
00D7 CA00D1                          JZ CHK4
00DA FE0E                            CPI 0EH
00DC CA00E0                          JZ CHK5
00DF E9                              PCHL

00E0 DB00        CHK5                IN 00H              ;CHK FOR 1,2,3
00E2 E60F                            ANI 0FH             ;OR NONE.
00E4 FE00                            CPI 00H
00E6 CA00EF                          JZ OK
00E9 E601                            ANI 01H
00EB CA00E0                          JZ CHK5
00EE E9                              PCHL

00EF 21A001      OK                  LXI H,DIA           ;LOAD DIA
00F2 4E                              MOV C,M
00F3 46                              MOV B,M

00F4 21A002                          LXI H,PRB1          ;COMP WITH #1
00F7 7E                              MOV A,M
00F8 91                              SUB C
00F9 7E                              MOV A,M
00FA 98                              SBB B
00FB DA008A                          JC RESTART

00FE 21A800                          LXI H,PRB3          ;COMP WITH #3
0101 7E                              MOV A,M
0102 91                              SUB C
0103 7E                              MOV A,M
0104 98                              SBB B
0105 DA008A                          JC RESTART

0108 CD0174                          CALL BCD            ;CALC MAX OFFSET
010B CD015B                          CALL MULT
010E 3AA801                          LDA OFFSET          ;COMP W/ OFFSET
0111 5F                              MOV E,A
0112 3E99                            MVI A,99H
0114 93                              SUB E
0115 BC                              CMP H               ;CY=1 IF A<H
0116 D2008A                          JNC RESTART

0119 2A2002                          LHLD DATA           ;LD DATA ADDR
```

```
011C CD017D                 CALL STORE1     ;STORE DIA

011F EB                     XCHG            ;DE<DATA
0120 21A800                 LXI H,PRB3      ;LOAD #3
0123 CD0182                 CALL STORE2
0126 EB                     XCHG            ;HL<DATA

0127 3AA000                 LDA VEL         ;LOAD VEL
012A 47                     MOV B,A
012B 3AA802                 LDA CURVE       ;LOAD CURVE
012E 4F                     MOV C,A
012F CD0174                 CALL BCD
0132 CD017D                 CALL STORE1     ;SAVE BOTH

0135 222002                 SHLD DATA       ;SAVE DATA PTR

0138 3A2001                 LDA DISPCNT     ;DISP DATA CNT
013B 3C                     INR A
013C 322001                 STA DISPCNT
013F CD036E                 CALL 36EH

0142 C3008A                 JMP RESTART

0145 21B000       EXIT      LXI H,FREQCNT   ;SAVE FREQ
0148 112004                 LXI D,FREQDAT   ;IN  2004.
014B CD0182                 CALL STORE2
014E CD0182                 CALL STORE2
0151 CD0182                 CALL STORE2

0154 21B802                 LXI H,CLOCK     ;SAVE TIME
0157 CD0182                 CALL STORE2     ;IN 200A.

015A CF                     RST 1           ;WARM START

015B 3A2000       MULT      LDA EPSILLON    ;INIT A,E,H&L
015E 5F                     MOV E,A         ;BC X .E = H.L
015F 210000                 LXI H,00H
0162 AF                     XRA A

0163 7D           MULT0     MOV A,L         ;ADD LOW BYTE
0164 81                     ADD C
0165 27                     DAA
0166 6F                     MOV L,A

0167 7C                     MOV A,H         ;ADD HIGH BYTE
0168 88                     ADC B
0169 27                     DAA
016A 67                     MOV H,A
```

```
016B 3E99                  MVI A,99H       ;A=E-1
016D 83                    ADD E
016E 27                    DAA
016F 5F                    MOV E,A

0170 C20163                JNZ MULT0       ;CHK IF DONE
0173 C9                    RET


0174 3E99       BCD        MVI A,99H       ;MAKE CNTR
0176 90                    SUB B           ;VALUES BCD.
0177 47                    MOV B,A
0178 3E99                  MVI A,99H
017A 91                    SUB C
017B 4F                    MOV C,A
017C C9                    RET

017D 70         STORE1     MOV M,B
017E 23                    INX H
017F 71                    MOV M,C
0180 23                    INX H
0181 C9                    RET

0182 4E         STORE2     MOV C,M         ;GET DATA
0183 46                    MOV B,M         ;FROM CNTR
0184 CD0174                CALL BCD
0187 EB                    XCHG            ;HL<DATA
0188 70                    MOV M,B         ;PUT DATA
0189 23                    INX H           ;IN MEMORY
018A 71                    MOV M,C
018B 23                    INX H
018C EB                    XCHG            ;DE<DATA
018D 23                    INX H
018E C9                    RET

Errors=    0
```

Appendix C

DESCRIPTION OF CALIBRATION PROCEDURE FOR COMPARATOR CIRCUIT

The circuit shown in Figure 38 is a non-inverting comparator with hysteresis. The actual outputs from a signal amplifier circuit and a comparator without hysteresis are shown in Figure 38A and Figure 38B respectively. Clearly, the amplifier has failed to accurately determine the timing of bubbles reaching and leaving the probe, and the comparator without hysteresis has failed to prevent the oscillation caused by the raining inside the bubbles. Only the non-inverting comparator with hysteresis can preprocess the four probe sensor signals to make it well defined and digital compatible for use by an Intel 8085 data-logger. An actual recorder output from this comparator circuit is given in Figure 39.

The sensor signal is a function of both the LED/ photo-cell sensor and the density of the bed at the sensor sight, it is therefore necessary to tune each of the four comparator circuits to its associated sensor. Two set points are used to determine the output of the comparator . The first point (V_{H1}) is set near the upper limit of the sensor signal range. This set point is used to set the comparator output (V_0) at 5 volts for

$$V_i \left(\frac{R_f}{R_i + R_f} \right) > V_{ref} \qquad (41)$$

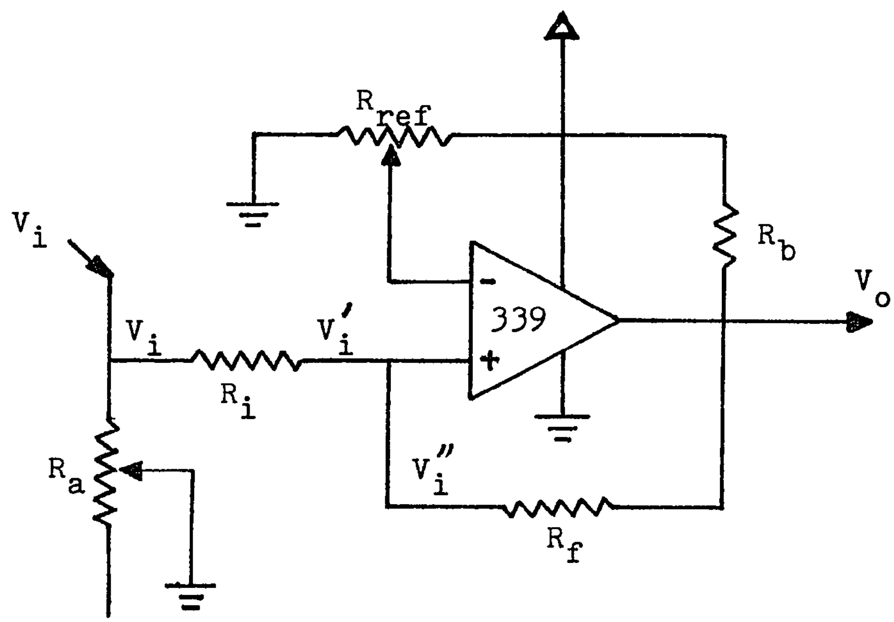

Figure 38. Schematic diagram of a non-inverting comparator with hysteresis.

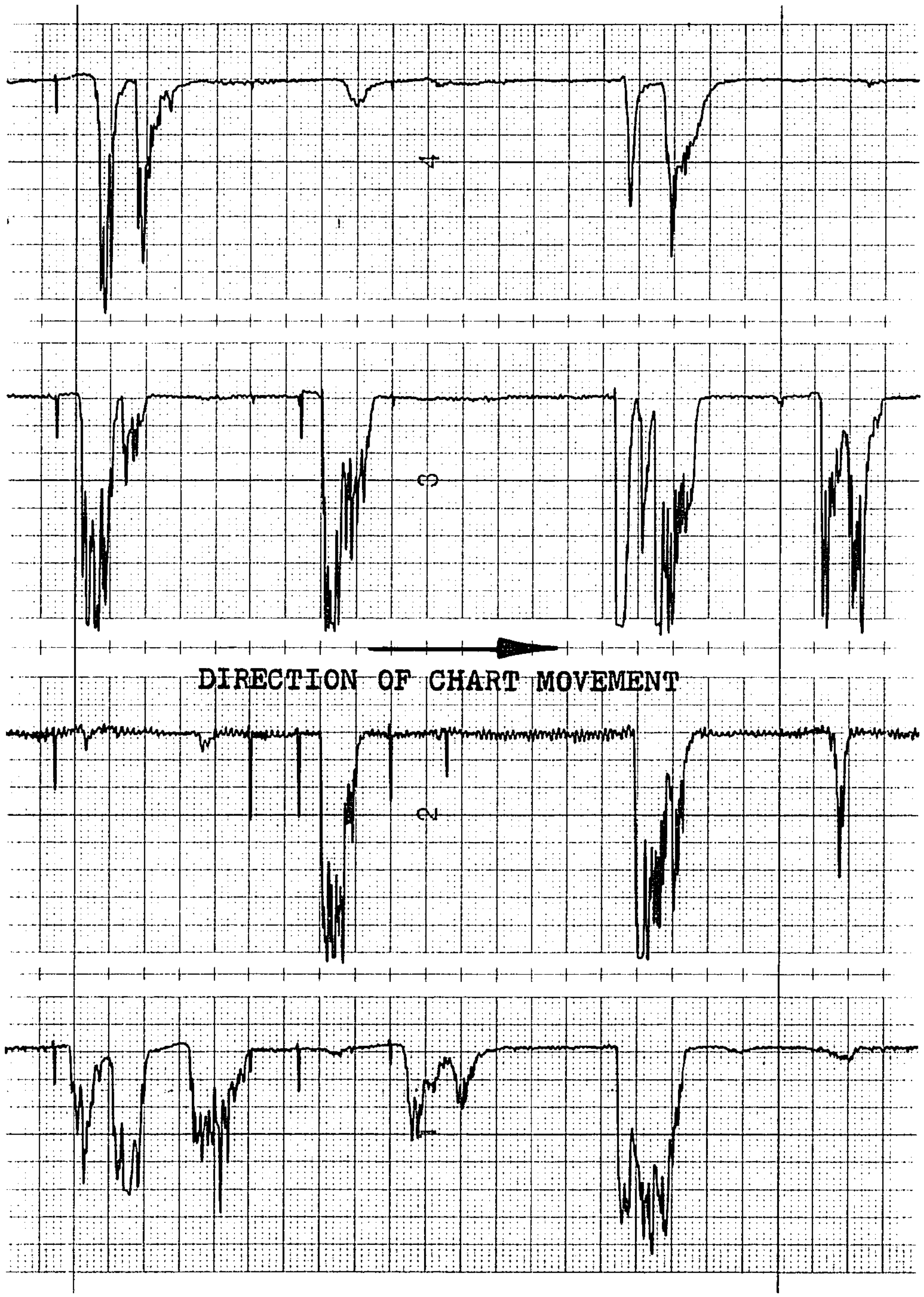

Figure 38A. An actual amplifier circuit output activated by the probe.

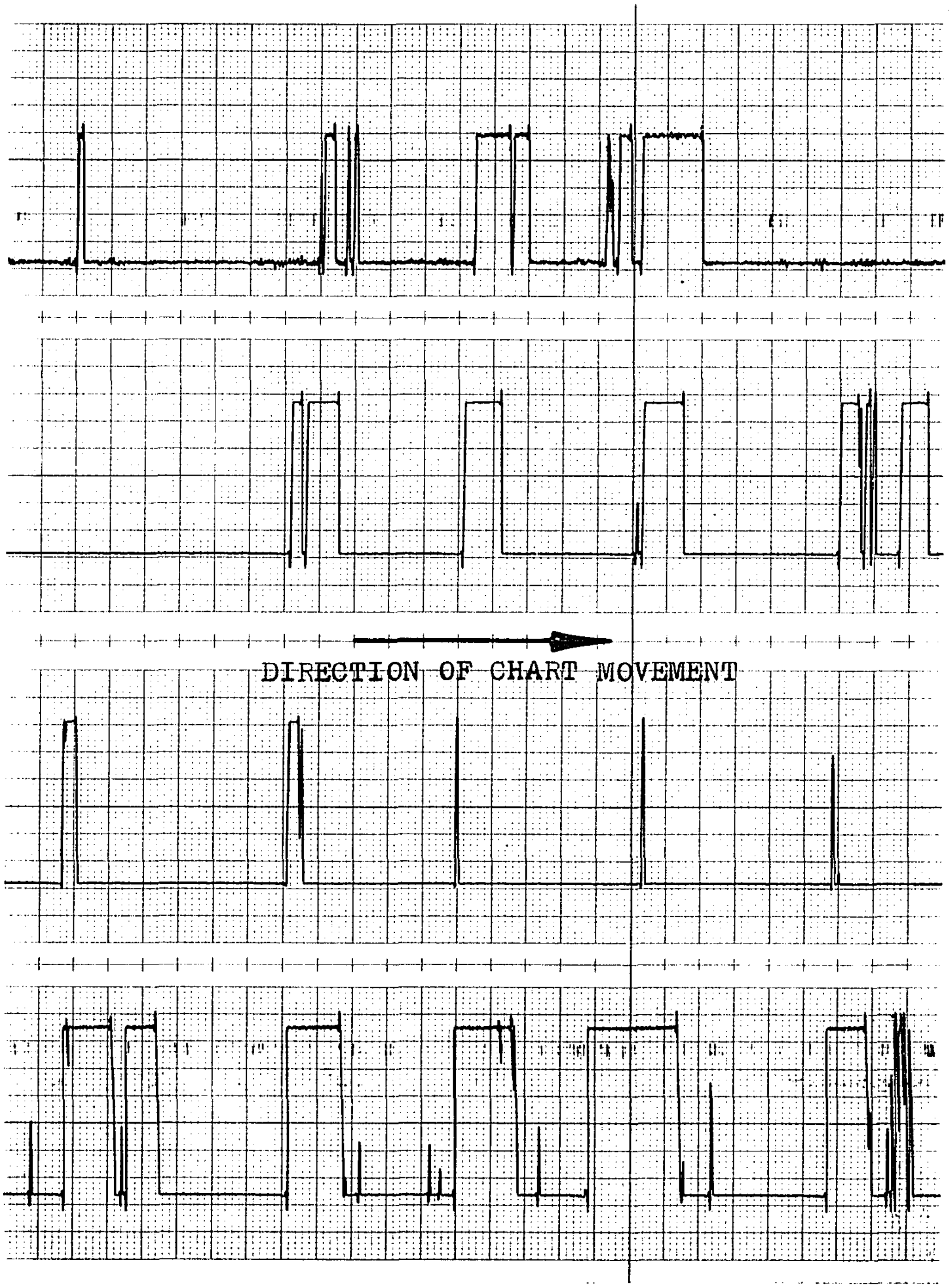

Figure 38B. An actual comparator output without the hysteresis effect.

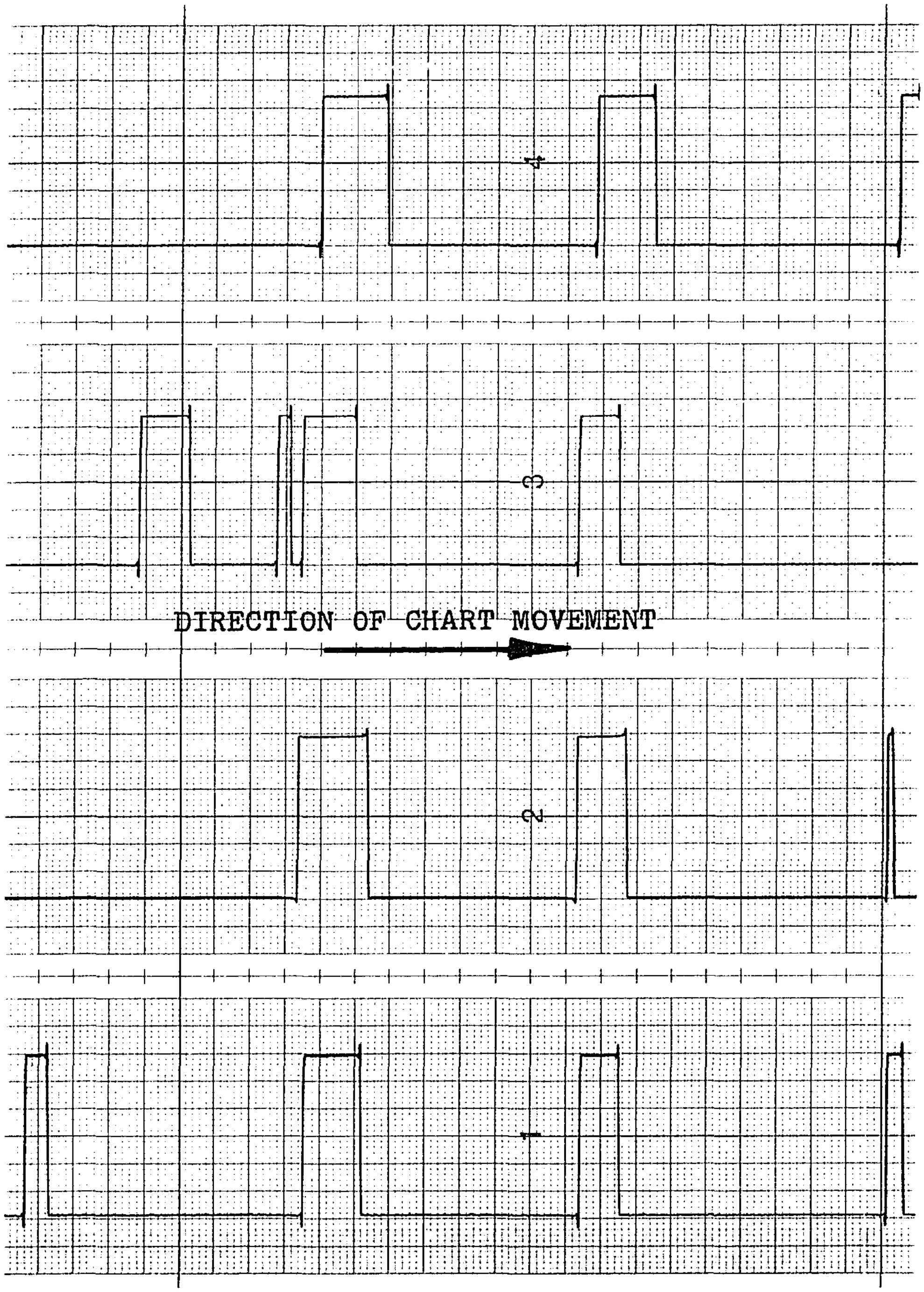

Figure 39. An actual comparator output recorded on a chart with the hysteresis effect.

The voltage of V_{H1} is

$$V_{H1} = V_{ref} \left(\frac{R_i + R_f}{R_f} \right). \tag{42}$$

The second set point (V_{H2}) is set near the lower sensor signal limit. For the signal voltage below V_{H2},

$$V_i + (V_0 - V_i) \left(\frac{R_i}{R_i + R_f} \right) < V_{ref} \tag{43}$$

the comparator output will be reset. The second set point value is

$$V_{H2} = \left[V_{ref} - V_0 \left(\frac{R_i}{R_i + R_f} \right) \right] \left(\frac{R_i + R_f}{R_f} \right) \tag{44}$$

This method of switching the comparator output provides hysteresis by incorporating positive feed back in the comparator circuit, where the width of the hysteresis window (ΔV) is

$$V_{H1} - V_{H2} = V_0 \frac{R_i}{R_f} \tag{45}$$

Figure 40 shows this kind of input-output characteristic. The noise immunity of the circuit is greatly improved because of the hysteresis.

Once the signal width, hysteresis window width, and signal bias becomes known, V_{H1} and V_{H2} can be set

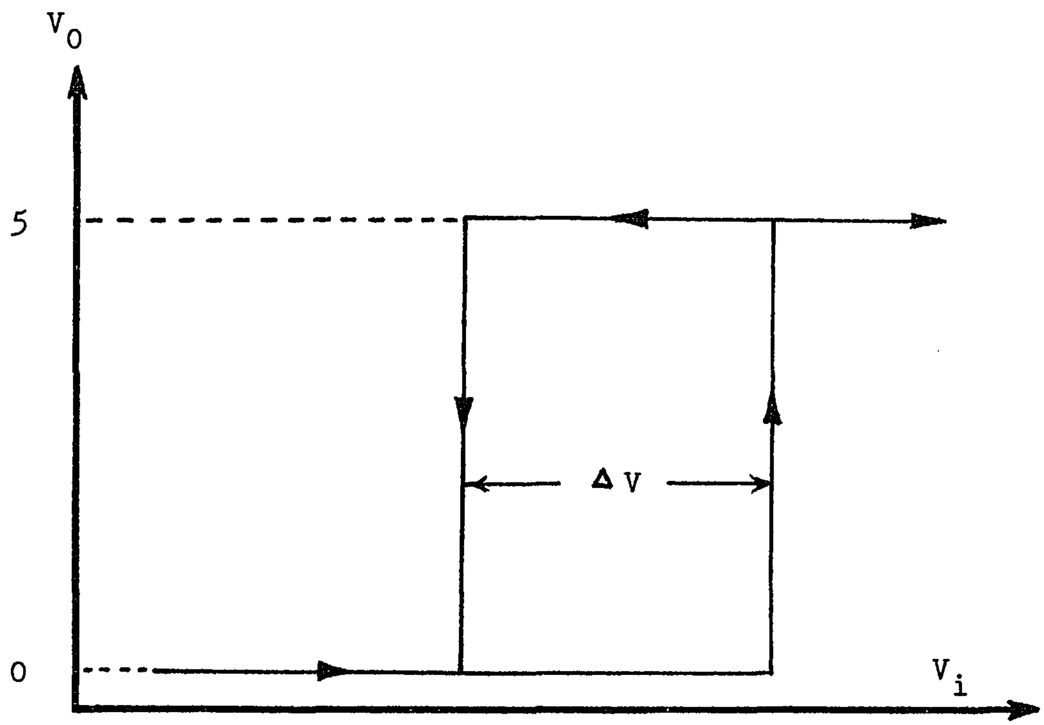

Figure 40. Input-output characteristic of a comparator with hysteresis.

indirectly by using V_{ref}. The detailed procedure is as follows:

1. Measure the V_i at high and at low to determine the signal width.
2. Calculate the hysteresis window width by Equation (45).
3. Adjust the attenuator to bring the ratio of the signal width to the hysteresis window width below 1.25 in order to get a better result.
4. Set V_{ref} value in between V_i at high and V_i at low by adjusting R_{ref}.
5. Determine V_{H1} and V_{H2} by Equation (42) and Equation (44) respectively.

APPENDIX D

DATA COLLECTED FOR BUBBLE CHARACTERISTICS ANALYSIS

3-D BED   PROBE POSITION=(8CM,55CM)

SUPERFICIAL GAS VELOCITY=12.46CM/SEC   PARTICLE SIZE:250-355

UB	AL	RF	RR	RW	VB	DE	SHAPE
68.18	6.68	3.42	0.78	4.53	167.5	6.84	S.G.D.
83.33	7.33	4.02	2.09	16.51	268.1	8.00	S.G.D.
65.22	4.57	4.57	4.52	16.61	219.9	7.49	S.G.D.
78.95	7.42	4.07	2.30	--	275.9	8.08	S.G.
75.00	6.60	4.02	2.43	5.01	259.2	7.91	S.G.D.
65.22	5.35	3.49	2.80	16.61	157.0	6.69	S.G.D.
88.24	6.35	6.72	6.64	16.48	682.8	10.93	S.G.D.
75.00	7.35	3.32	5.26	15.14	318.7	8.47	P.C.
93.75	5.62	12.16	10.25	--	1022.2	12.53	S.L.
71.43	6.71	3.48	1.28	--	175.7	6.95	S.G.
83.33	7.67	4.02	1.55	16.51	271.7	8.04	S.G.D.
83.33	8.17	4.02	7.00	--	628.6	10.63	PAR.
55.56	1.56	13.65	13.62	13.65	909.2	12.02	S.G.D.
83.33	9.17	3.32	5.56	--	445.5	9.48	PAR.
62.50	6.50	3.48	1.58	16.62	174.5	6.93	S.G.D.
71.43	5.57	4.06	3.59	16.57	224.0	7.54	S.G.D.
71.43	6.57	3.59	2.00	--	189.9	7.13	S.G.
88.24	8.29	3.50	6.20	--	501.0	9.85	PAR.
75.00	5.85	4.55	4.16	16.55	295.2	8.26	S.G.D.
83.33	8.33	4.02	7.07	--	654.5	10.77	PAR.
100.00	8.40	3.64	6.87	--	623.4	10.60	PAR.
83.33	7.83	4.02	1.30	--	272.5	8.04	S.G.
78.95	10.11	5.45	2.84	--	668.6	10.85	S.G.
88.24	8.12	3.44	5.87	--	439.9	9.44	PAR.
93.75	8.06	3.36	5.96	12.16	448.0	9.49	P.C.
83.33	7.50	4.02	2.03	--	269.5	8.01	S.G.
71.43	5.43	4.06	3.66	16.57	218.1	7.47	S.G.D.
68.18	6.14	3.51	2.33	--	173.4	6.92	S.G.
78.95	6.63	3.30	4.55	16.53	215.7	7.44	P.C.
88.24	7.94	3.44	6.24	16.48	485.1	9.75	P.C.
75.00	6.60	7.80	7.71	--	766.2	11.38	S.L.
75.00	7.35	3.32	5.23	16.55	315.1	8.44	P.C.
55.56	1.56	13.65	11.47	16.35	395.2	9.10	S.L.D.
88.24	5.29	6.72	6.72	16.48	533.7	10.06	S.G.D.
68.18	4.77	4.53	4.45	16.59	229.9	7.60	S.G.D.
78.95	7.26	4.07	2.30	16.53	274.6	8.06	S.G.D.
107.14	13.07	3.33	7.18	16.38	1056.1	12.63	P.C.

65.22	6.39	4.10	3.17	16.61	258.4	7.90	S.G.D.
88.24	8.12	3.44	6.31	16.48	507.0	9.89	P.C.
83.33	8.00	4.02	0.63	--	273.1	8.05	S.G.
62.50	6.50	3.48	1.58	16.28	174.5	6.93	S.G.D.
78.95	8.68	3.41	5.95	--	482.3	9.73	PAR.
75.00	6.90	4.02	2.30	6.37	263.3	7.95	S.G.D.
93.75	10.69	5.46	1.38	16.45	681.4	10.92	S.G.D.
83.33	7.83	4.02	1.17	16.51	272.7	8.05	S.G.D.
65.22	5.87	3.41	2.20	16.61	158.6	6.72	S.G.D.
88.24	6.35	6.72	6.71	--	583.9	10.40	S.L.
71.43	3.57	6.79	5.98	--	224.3	7.56	S.L.
88.24	6.00	6.72	6.69	16.48	633.6	10.66	S.G.D.
78.95	8.84	3.41	6.00	--	500.0	9.85	PAR.
78.95	6.32	4.19	3.62	--	261.8	7.94	S.G.
83.33	6.83	4.57	3.64	13.65	348.6	8.73	S.G.D.
78.95	7.58	4.07	2.06	--	278.2	8.10	S.G.
65.22	5.87	3.54	2.49	16.25	173.9	6.93	S.G.D.
88.24	5.82	6.72	6.66	--	509.4	9.94	S.L.
65.22	4.57	4.57	4.52	16.61	219.9	7.49	S.G.D.
93.75	9.37	3.36	6.26	16.45	576.1	10.32	P.C.
100.00	11.40	7.80	3.55	3.55	1884.1	15.32	S.G.D.
65.22	6.26	3.49	1.97	16.61	174.1	6.93	S.G.D.
107.14	13.07	3.33	7.18	16.38	1056.1	12.63	P.C.
71.43	3.43	8.49	7.93	16.57	418.8	9.28	S.L.D.
88.24	5.65	6.72	6.71	16.48	583.8	10.37	S.G.D.
100.00	9.20	7.80	7.18	16.41	1411.1	13.92	S.G.D.
78.95	8.68	7.64	3.76	4.07	1631.2	14.60	S.G.D.
83.33	7.67	4.02	1.71	--	271.3	8.03	S.G.
71.43	3.57	8.49	6.92	--	292.6	8.26	S.L.
83.33	8.17	4.02	7.79	16.51	775.2	11.40	P.C.
93.75	6.00	12.16	10.48	--	1148.9	13.03	S.L.
83.33	8.33	4.02	7.07	--	654.5	10.77	PAR.
100.00	9.40	7.80	7.63	--	1295.2	13.52	S.G.
100.00	11.60	6.03	2.29	--	913.1	12.04	S.G.
93.75	7.87	3.36	6.32	8.27	480.4	9.72	P.C.
88.24	6.18	6.72	6.67	16.48	658.3	10.79	S.G.D.
93.75	11.44	3.46	7.06	--	896.7	11.96	PAR.
75.00	7.50	3.32	5.00	--	294.5	8.25	PAR.
83.33	7.50	4.12	2.35	--	286.0	8.17	S.G.
71.43	3.57	5.68	5.27	--	179.8	7.02	S.L.
78.95	5.53	4.19	3.80	16.53	236.7	7.67	S.G.D.
93.75	8.44	3.36	5.58	--	412.9	9.24	PAR.
100.00	8.60	4.08	7.44	--	746.8	11.26	PAR.
75.00	7.35	3.32	4.95	--	282.9	8.14	PAR.
88.24	6.18	4.52	3.99	16.48	309.2	8.39	S.G.D.
55.56	1.78	10.33	5.79	--	96.6	5.71	S.L.
75.00	5.55	4.11	3.67	16.55	228.1	7.58	S.G.D.
88.24	7.94	3.50	6.57	16.48	536.9	10.08	P.C.
62.50	6.50	3.48	1.49	9.26	174.7	6.94	S.G.D.
78.95	8.05	3.65	6.77	--	580.6	10.35	PAR.

68.18	6.68	3.62	1.95	--	196.0	7.21	S.G.
93.75	6.37	8.27	8.05	--	784.8	11.48	S.L.
83.33	7.67	4.02	1.55	16.51	271.7	8.04	S.G.D.
71.43	6.43	3.59	2.20	--	187.9	7.11	S.G.
88.24	6.18	4.52	3.99	16.48	309.2	8.39	S.G.D.
68.18	6.55	3.46	1.58	--	172.4	6.91	S.G.
88.24	7.94	3.39	5.58	--	388.6	9.05	PAR.
88.24	5.65	6.72	6.64	--	484.9	9.77	S.L.
71.43	5.57	4.06	3.77	--	215.2	7.44	S.G.
88.24	7.94	3.44	6.24	16.48	485.1	9.75	P.C.
65.22	6.26	3.49	2.13	--	173.3	6.92	S.G.
75.00	10.50	3.50	6.96	--	799.3	11.51	PAR.
93.75	9.37	3.36	5.88	--	509.8	9.91	PAR.

3-D BED PROBE POSITION=(OCM,55CM)

SUPERFICIAL GAS VELOCITY=12.46CM/SEC PARTICLE SIZE:250-355

UB	AL	RF	RR	RW	VB	DE	SHAPE
75.00	5.55	4.11	3.67	16.55	228.1	7.58	S.G.D.
83.33	6.83	4.57	3.64	13.65	348.6	8.73	S.G.D.
107.14	5.79	7.33	7.16	---	567.5	10.30	S.L.
68.18	6.82	3.62	1.72	---	197.5	7.23	S.G.
93.75	10.69	5.46	1.38	16.45	681.4	10.92	S.G.D.
55.56	1.89	10.33	5.95	---	108.7	5.94	S.L.
93.75	11.06	3.46	6.95	---	838.8	11.70	PAR.
75.00	7.35	3.32	4.95	---	282.9	8.14	PAR.
71.43	3.57	5.68	5.27	---	179.8	7.02	S.L.
93.75	8.44	3.36	5.58	---	412.9	9.24	PAR.
100.00	11.60	3.33	6.72	16.41	820.8	11.62	P.C.
78.95	5.53	4.19	3.80	16.53	236.7	7.67	S.G.D.
68.18	6.14	3.51	2.33	---	173.4	6.92	S.G.
78.95	8.53	3.41	6.31	16.53	532.2	10.05	P.C.
78.95	8.05	3.65	6.77	---	580.6	10.35	PAR.
88.24	9.71	3.39	4.86	---	359.4	8.82	PAR.
88.24	7.94	3.50	6.57	16.48	536.9	10.08	P.C.
100.00	8.60	4.08	7.44	---	746.8	11.26	PAR.
78.95	7.26	4.07	2.52	---	273.0	8.05	S.G.
88.24	5.65	6.72	6.71	16.48	583.8	10.37	S.G.D.
88.24	9.71	3.44	6.91	16.48	725.4	11.15	P.C.
93.75	5.25	12.16	10.00	---	901.3	12.02	S.L.
88.24	5.29	6.72	6.72	16.48	533.7	10.06	S.G.D.
93.75	10.50	3.52	7.10	---	831.3	11.67	PAR.
100.00	11.80	6.03	1.73	---	915.7	12.05	S.G.
65.22	6.78	3.54	1.23	8.87	185.7	7.08	S.G.D.
78.95	7.42	4.07	2.30	---	275.9	8.08	S.G.
93.75	8.25	3.36	5.87	16.45	445.9	9.48	P.C.
55.56	1.78	10.33	8.04	16.66	205.6	7.32	S.L.D.
78.95	8.68	3.41	6.37	16.53	552.1	10.18	P.C.
107.14	6.00	7.33	7.20	---	602.3	10.51	S.L.
65.22	6.39	4.10	3.17	16.61	258.4	7.90	S.G.D.
83.33	8.00	4.02	0.63	---	273.1	8.05	S.G.
88.24	8.29	3.44	5.94	---	459.3	9.57	PAR.
78.95	10.11	5.45	2.84	---	668.6	10.85	S.G.
68.18	6.55	3.46	1.58	---	172.4	6.91	S.G.
93.75	10.87	5.46	0.71	---	682.1	10.92	S.G.

83.33	10.83	4.18	4.39	16.51	328.1	8.56	P.C.
88.24	8.29	3.50	6.20	--	501.0	9.85	PAR.
115.38	12.23	3.39	6.91	--	916.4	12.05	PAR.
75.00	6.90	4.02	2.30	6.37	263.3	7.95	S.G.D.
88.24	5.29	6.72	6.72	16.48	533.7	10.06	S.G.D.
88.24	6.00	6.72	6.69	16.48	633.6	10.66	S.G.D.
62.50	6.50	3.48	1.58	16.62	174.5	6.93	S.G.D.
78.95	7.26	4.07	2.52	--	273.0	8.05	S.G.
75.00	10.50	3.45	6.71	--	742.2	11.23	PAR.
93.75	11.06	3.46	6.95	--	838.8	11.70	PAR.
107.14	13.07	3.33	7.18	16.38	1056.1	12.63	P.C.
107.14	15.21	3.50	5.16	7.33	2110.6	15.91	P.C.
107.14	5.79	10.71	9.51	--	923.3	12.11	S.L.
83.33	7.33	4.02	2.09	16.51	268.1	8.00	S.G.D.
93.75	8.06	3.36	5.96	12.16	448.0	9.49	P.C.
93.75	10.69	5.46	1.58	--	681.2	10.92	S.G.
62.50	6.50	3.48	1.49	9.26	174.7	6.94	S.G.D.
75.00	7.35	3.32	5.23	16.55	315.1	8.44	P.C.
88.24	7.94	3.44	6.24	16.48	485.1	9.75	P.C.
71.43	3.57	5.68	5.27	--	179.8	7.02	S.L.
93.75	10.69	4.56	9.25	--	1435.4	14.00	PAR.
88.24	7.94	3.50	6.57	16.48	536.9	10.08	P.C.
93.75	10.69	3.52	7.16	--	861.2	11.80	PAR.
78.95	5.53	4.19	3.80	16.53	236.7	7.67	S.G.D.
68.18	6.68	3.62	1.95	--	196.0	7.21	S.G.
88.24	5.29	6.72	6.72	16.48	533.7	10.06	S.G.D.
65.22	5.87	3.54	2.49	16.25	173.9	6.93	S.G.D.
93.75	10.69	5.46	1.38	16.45	681.4	10.92	S.G.D.
83.33	10.50	3.54	7.18	--	850.2	11.75	PAR.
71.43	6.43	3.59	2.20	--	187.9	7.11	S.G.
88.24	5.47	6.72	6.72	16.48	558.7	10.22	S.G.D.
83.33	7.83	4.02	1.17	16.51	272.7	8.05	S.G.D.
88.24	9.71	3.44	6.91	16.48	725.4	11.15	P.C.
83.33	4.83	5.92	5.92	16.51	374.8	8.95	S.G.D.
88.24	6.18	6.72	6.70	--	558.9	10.25	S.L.
71.43	6.71	3.48	1.16	15.86	175.8	6.95	S.G.D.
107.14	6.43	10.71	9.82	--	1112.0	12.89	S.L.
93.75	10.31	8.27	5.84	6.37	2000.6	15.63	S.G.D.
75.00	6.60	3.55	1.43	5.01	186.2	7.09	S.G.D.
83.33	7.50	4.12	2.35	--	286.0	8.17	S.G.
93.75	11.44	3.46	7.06	--	896.7	11.96	PAR.
93.75	7.87	3.36	6.32	8.27	480.4	9.72	P.C.
107.14	7.07	5.68	5.50	--	521.6	9.99	S.G.
93.75	11.06	3.46	6.95	--	838.8	11.70	PAR.
88.24	7.94	3.39	5.58	--	388.6	9.05	PAR.
71.43	6.29	3.59	2.19	16.57	186.9	7.09	S.G.D.
83.33	7.67	4.02	1.71	--	271.3	8.03	S.G.
78.95	8.84	3.41	6.00	--	500.0	9.85	PAR.

75.00	7.05	3.55	0.57	16.55	187.8	7.11	S.G.D.
78.95	6.63	3.30	4.55	16.53	215.7	7.44	P.C.
83.33	4.83	5.92	5.92	16.51	374.8	8.95	S.G.D.
88.24	8.12	3.44	5.87	--	439.9	9.44	PAR.
78.95	7.58	4.07	1.86	16.53	278.9	8.11	S.G.D.
65.22	5.87	3.41	2.20	16.61	158.6	6.72	S.G.D.
78.95	9.95	5.45	3.09	--	664.2	10.83	S.G.
71.43	5.57	4.06	3.77	--	215.2	7.44	S.G.
88.24	6.18	6.72	6.70	--	558.9	10.25	S.L.
78.95	7.26	3.34	5.09	--	295.2	8.26	PAR.
88.24	5.12	6.72	6.53	--	412.8	9.26	S.L.
93.75	9.37	3.36	6.44	12.16	606.7	10.50	P.C.
88.24	8.47	3.57	4.27	5.54	818.1	11.60	P.C.
93.75	13.50	3.36	7.06	--	1057.0	12.64	PAR.
83.33	13.17	3.54	4.02	5.05	1718.8	14.86	P.C.

3-D BED PROBE POSITION=(2CM,55CM)

SUPERFICIAL GAS VELOCITY=12.46CM/SEC PARTICLE SIZE:250-355

UB	AL	RF	RR	RW	VB	DE	SHAPE
93.75	11.81	3.60	4.97	--	457.4	9.56	PAR.
88.24	6.88	8.94	8.70	--	988.8	12.39	S.L.
65.22	5.22	4.57	4.39	16.61	260.7	7.93	S.G.D.
88.24	5.65	3.44	2.64	--	156.0	6.68	S.G.
83.33	8.50	7.22	6.70	16.51	1108.6	12.84	S.G.D.
55.56	1.78	10.33	5.79	--	96.6	5.71	S.L.
83.33	6.83	4.57	3.64	13.65	348.6	8.73	S.G.D.
83.33	7.33	4.02	2.09	16.51	268.1	8.00	S.G.D.
93.75	6.00	5.46	5.43	--	391.4	9.08	S.G.
65.22	6.00	7.24	7.13	--	592.4	10.45	S.L.
65.22	6.26	3.49	1.97	16.61	174.1	6.93	S.G.D.
68.18	4.50	4.53	4.53	--	192.8	7.19	S.L.
88.24	6.18	6.72	6.67	16.48	658.3	10.79	S.G.D.
60.00	5.04	4.99	4.99	--	263.9	7.96	S.G.
78.95	8.05	9.73	9.58	--	1434.7	14.03	S.L.
68.18	4.91	4.02	3.73	11.18	196.3	7.21	S.G.D.
83.33	6.50	4.02	3.17	--	246.7	7.78	S.G.
83.33	7.00	3.42	5.39	--	319.7	8.48	PAR.
51.72	9.21	3.46	7.18	11.09	735.4	11.20	P.C.
71.43	3.57	5.68	5.27	--	179.8	7.02	S.L.
83.33	4.83	4.12	4.06	--	184.0	7.06	S.G.
75.00	7.35	3.32	5.23	16.55	315.1	8.44	P.C.
93.75	7.87	3.36	6.32	8.27	480.4	9.72	P.C.
78.95	7.74	3.58	6.33	--	487.2	9.76	PAR.
100.00	9.20	3.42	6.13	--	543.9	10.13	PAR.
75.00	7.50	3.32	5.00	--	294.5	8.25	PAR.
50.00	5.90	5.49	5.34	16.69	427.0	9.34	S.G.D.
100.00	10.00	3.55	7.07	--	785.4	11.45	PAR.
83.33	10.83	4.18	4.39	16.51	328.1	8.56	P.C.
68.18	5.18	8.53	8.47	16.59	798.1	11.51	S.L.D.
88.24	9.71	3.39	4.86	--	359.4	8.82	PAR.
78.95	7.11	5.45	4.66	9.73	539.5	10.10	S.G.D.
93.75	8.25	3.30	4.69	6.38	424.9	9.33	P.C.
78.95	7.26	4.07	2.52	--	273.0	8.05	S.G.
88.24	8.12	3.44	5.87	--	439.9	9.44	PAR.
83.33	4.83	5.92	5.82	--	316.3	8.48	S.L.
78.95	7.26	3.37	5.25	--	314.9	8.44	PAR.
65.22	6.26	7.24	7.17	--	634.3	10.69	S.L.
88.24	7.94	3.39	5.58	--	388.6	9.05	PAR.
93.75	10.12	3.36	6.11	--	594.6	10.43	PAR.

55.56	1.78	10.33	8.04	16.66	205.6	7.32	S.L.D.
60.00	6.24	3.99	3.30	--	234.0	7.65	S.G.
115.38	9.69	3.34	4.93	6.85	688.6	10.96	P.C.
78.95	6.32	4.19	3.62	--	261.8	7.94	S.G.
83.33	11.00	4.18	4.31	--	320.7	8.49	PAR.
78.95	12.47	3.46	7.40	--	1071.6	12.70	PAR.
107.14	9.21	3.43	6.22	--	560.1	10.23	PAR.
50.00	4.60	4.08	4.05	--	169.3	6.86	S.G.
60.00	6.00	5.44	5.26	16.63	428.5	9.35	S.G.D.
57.69	2.88	9.98	7.02	--	235.8	7.69	S.L.
78.95	7.26	4.07	2.30	16.53	274.6	8.06	S.G.D.
78.95	8.68	3.41	5.95	--	482.3	9.73	PAR.
93.75	5.25	4.56	4.51	--	243.6	7.75	S.G.
93.75	8.06	3.36	5.96	12.16	448.0	9.49	P.C.
93.75	6.00	12.16	10.48	--	1148.9	13.03	S.L.
107.14	7.71	4.02	1.61	--	271.7	8.04	S.G.
100.00	7.40	6.03	5.87	--	612.5	10.54	S.G.
55.56	8.78	3.33	7.01	16.66	676.5	10.89	P.C.
88.24	5.29	6.72	6.57	--	436.5	9.44	S.L.
78.95	4.26	3.58	3.51	--	123.3	6.18	S.G.
75.00	5.25	5.01	5.00	--	282.2	8.14	S.G.
62.50	6.12	3.57	2.33	16.62	182.3	7.04	S.G.D.
75.00	7.50	3.32	5.00	--	294.5	8.25	PAR.
88.24	8.12	3.44	6.31	16.48	507.0	9.89	P.C.
60.00	4.20	7.80	7.61	16.31	496.3	9.82	S.L.D.
53.57	5.46	4.02	3.76	--	206.7	7.34	S.G.
88.24	7.94	3.39	5.58	--	388.6	9.05	PAR.
88.24	5.12	6.72	6.53	--	412.8	9.26	S.L.
75.00	3.00	5.01	4.59	--	113.4	6.02	S.L.
65.22	5.87	3.41	2.20	16.25	158.7	6.72	S.G.D.
78.95	5.37	3.58	3.10	--	162.2	6.77	S.G.
115.38	9.69	3.34	6.56	9.98	648.3	10.74	P.C.
51.72	3.52	6.78	5.94	--	217.9	7.49	S.L.
83.33	11.17	3.48	6.13	9.26	1142.2	12.97	P.C.
78.95	10.42	3.58	7.35	--	883.9	11.91	PAR.
75.00	8.40	3.30	4.90	--	316.7	8.46	PAR.
65.22	4.04	8.87	7.44	--	386.5	9.06	S.L.
75.00	7.65	3.32	5.05	--	306.4	8.36	PAR.
75.00	8.25	3.55	7.00	16.55	633.3	10.65	P.C.
100.00	9.20	7.80	7.18	16.41	1411.1	13.92	S.G.D.
68.18	6.27	3.46	2.02	--	169.6	6.87	S.G.
93.75	7.50	4.13	2.11	12.16	289.8	8.21	S.G.D.
100.00	11.20	3.64	8.80	16.41	1352.6	13.72	P.C.
62.50	5.62	4.52	4.20	16.62	278.7	8.10	S.G.D.
93.75	4.50	12.16	9.44	--	678.0	10.93	S.L.
88.24	15.18	3.32	6.38	--	971.1	12.29	PAR.
62.50	8.50	3.35	4.87	16.62	316.7	8.46	P.C.
71.43	6.86	5.05	4.43	16.57	429.1	9.36	S.G.D.

65.22	6.39	3.54	1.94	16.25	182.2	7.03	S.G.D.
88.24	6.00	3.65	2.36	6.72	191.5	7.15	S.G.D.
71.43	7.29	3.36	5.20	--	309.0	8.39	PAR.
83.33	4.83	5.92	5.92	16.51	374.8	8.95	S.G.D.
57.69	4.62	8.10	7.97	16.65	609.4	10.52	S.L.D.
88.24	5.82	6.72	6.66	--	509.4	9.94	S.L.
71.43	6.43	3.59	2.20	--	187.9	7.11	S.G.
53.57	2.68	4.99	4.42	--	92.4	5.62	S.L.
75.00	7.35	3.30	5.07	16.55	296.7	8.28	P.C.
78.95	8.05	6.33	6.10	--	743.7	11.24	S.G.
115.38	13.38	3.31	6.40	16.33	859.2	11.79	P.C.
55.56	6.22	3.36	1.61	16.66	156.3	6.68	S.G.D.

3-D BED PROBE POSITION=(4CM,55CM)

SUPERFICIAL GAS VELOCITY=12.46CM/SEC PARTICLE SIZE:250-355

UB	AL	RF	RR	RW	VB	DE	SHAPE
45.45	4.64	7.64	7.55	16.22	556.1	10.20	S.L.D.
57.69	6.46	6.85	6.84	--	616.1	10.59	S.L.
62.50	6.87	5.05	4.71	--	409.3	9.21	S.G.
55.56	1.78	10.33	5.79	--	96.6	5.71	S.L.
93.75	7.12	4.56	3.78	--	349.1	8.74	S.G.
75.00	7.65	3.45	5.73	--	394.0	9.10	PAR.
78.95	5.53	4.19	3.80	16.53	236.7	7.67	S.G.D.
115.38	11.54	3.45	4.24	5.47	600.4	10.47	P.C.
60.00	4.68	5.44	5.39	--	267.1	8.01	S.L.
78.95	6.63	3.30	4.55	16.53	215.7	7.44	P.C.
83.33	10.83	4.18	4.39	16.51	328.1	8.56	P.C.
78.95	7.26	3.34	5.09	--	295.2	8.26	PAR.
68.18	6.82	3.35	5.00	--	267.7	8.00	PAR.
88.24	7.94	3.39	5.58	--	388.6	9.05	PAR.
71.43	8.43	3.59	3.79	4.59	848.7	11.75	P.C.
115.38	10.85	3.63	6.49	9.98	1369.3	13.78	P.C.
88.24	10.06	3.30	5.49	--	476.8	9.69	PAR.
88.24	6.35	6.72	6.64	16.48	682.8	10.93	S.G.D.
88.24	8.12	3.44	5.87	--	439.9	9.44	PAR.
88.24	9.71	3.30	5.67	16.48	489.4	9.78	P.C.
75.00	6.90	3.40	5.25	--	299.1	8.30	PAR.
65.22	6.26	3.60	2.24	16.61	187.5	7.10	S.G.D.
78.95	8.53	3.41	6.31	16.53	532.2	10.05	P.C.
62.50	4.62	3.52	3.35	--	133.2	6.34	S.G.
93.75	7.87	3.36	6.32	8.27	480.4	9.72	P.C.
88.24	5.65	6.72	6.71	16.48	583.8	10.37	S.G.D.
88.24	5.12	6.72	6.72	16.48	508.6	9.90	S.L.D.
62.50	6.12	3.33	1.80	--	151.3	6.61	S.G.
57.69	7.27	4.09	2.57	--	276.5	8.08	S.G.
107.14	18.43	4.67	5.26	--	800.2	11.52	PAR.
100.00	7.80	3.33	4.54	--	253.0	7.85	PAR.
71.43	5.29	4.59	4.53	--	247.9	7.79	S.G.
62.50	5.50	4.09	3.67	16.62	224.4	7.54	S.G.D.
57.69	4.96	9.98	8.63	--	644.1	10.74	S.L.
83.33	11.00	4.18	4.31	--	320.7	8.49	PAR.
78.95	5.68	7.64	7.10	7.64	995.5	12.39	S.G.D.
57.69	6.92	3.54	1.01	--	184.9	7.07	S.G.
57.69	6.23	3.39	1.70	16.65	160.2	6.74	S.G.D.
78.95	7.26	4.07	2.52	--	273.0	8.05	S.G.

71.43	4.29	8.49	7.38	--	407.6	9.22	S.L.
65.22	6.78	5.48	5.07	16.61	500.8	9.85	S.G.D.
60.00	5.52	5.44	5.44	--	344.8	8.70	S.G.
50.00	3.20	6.80	6.39	16.69	251.2	7.83	S.L.D.
55.56	4.33	10.33	8.41	--	523.9	10.03	S.L.
65.22	5.35	16.25	16.15	16.61	4202.8	20.02	S.G.D.
57.69	5.54	3.45	2.75	--	154.8	6.66	S.G.
65.22	9.78	3.49	6.71	--	691.5	10.97	PAR.
53.57	2.68	4.56	4.16	--	82.7	5.42	S.L.
88.24	8.29	3.44	5.94	--	459.3	9.57	PAR.
57.69	7.15	3.58	0.27	16.65	192.7	7.17	S.G.D.
100.00	9.20	3.55	4.44	--	284.9	8.16	PAR.
60.00	4.20	4.55	4.54	16.63	194.9	7.19	S.G.D.
68.18	6.82	4.02	2.90	--	255.9	7.88	S.G.
53.57	2.68	4.56	4.16	--	82.7	5.42	S.L.
78.95	8.53	3.41	6.31	16.53	532.2	10.05	P.C.
100.00	8.00	3.33	4.60	--	266.1	7.98	PAR.
65.22	4.83	4.84	4.19	4.84	325.0	8.53	S.G.D.
88.24	8.12	3.50	6.64	16.48	561.1	10.23	P.C.
57.69	5.77	3.54	2.74	--	168.6	6.85	S.G.
83.33	8.17	4.02	7.79	16.51	775.2	11.40	P.C.
78.95	8.05	3.65	6.77	--	580.6	10.35	PAR.
107.14	9.00	3.59	6.87	--	668.0	10.85	PAR.
78.95	8.84	3.34	5.61	--	437.5	9.42	PAR.
78.95	5.37	4.97	4.58	7.64	346.4	8.71	S.G.D.
65.22	6.39	3.54	1.94	16.25	182.2	7.03	S.G.D.
65.22	8.87	3.41	6.00	--	501.6	9.86	PAR.
100.00	10.40	3.33	5.25	--	449.7	9.51	PAR.
83.33	9.67	4.57	10.04	16.51	1510.6	14.24	P.C.
53.57	2.57	4.99	4.37	--	85.9	5.49	S.L.
88.24	6.00	3.65	2.36	6.72	191.5	7.15	S.G.D.
75.00	7.35	3.32	4.95	--	282.9	8.14	PAR.
83.33	7.67	3.32	5.09	--	311.6	8.41	PAR.
115.38	7.85	6.85	5.62	6.85	1030.4	12.53	S.G.D.
78.95	6.63	3.30	4.46	--	207.2	7.34	PAR.
53.57	6.11	4.02	3.44	--	233.1	7.64	S.G.
65.22	4.57	3.66	3.54	--	139.9	6.44	S.G.
71.43	5.86	4.59	4.41	--	283.9	8.15	S.G.
93.75	6.19	8.27	8.01	--	746.9	11.29	S.L.
71.43	5.86	3.59	2.60	16.57	179.0	6.99	S.G.D.
44.12	4.24	8.94	8.64	16.72	642.3	10.70	S.L.D.
71.43	7.43	5.68	5.06	15.86	592.9	10.42	S.G.D.
68.18	7.36	3.35	5.52	16.59	351.9	8.76	P.C.
62.50	6.37	7.65	7.63	16.62	871.7	11.85	S.G.D.
107.14	9.43	3.59	7.04	--	733.1	11.19	PAR.
71.43	7.43	3.48	5.78	--	390.1	9.07	PAR.
62.50	4.37	9.26	9.23	12.16	881.5	11.90	S.L.D.
88.24	8.29	3.65	4.27	5.54	883.3	11.90	P.C.

78.95	6.63	3.37	0.87	.--	160.5	6.74	S.G.
88.24	5.29	3.35	2.57	16.48	142.0	6.47	S.G.D.
68.18	5.18	4.10	3.81	16.59	211.1	7.39	S.G.D.
71.43	5.29	4.15	3.99	--	209.3	7.37	S.G.
78.95	7.26	4.19	2.62	16.53	296.6	8.27	S.G.D.
93.75	9.37	3.36	4.69	6.38	682.2	10.92	P.C.
57.69	4.50	4.58	4.55	16.65	216.7	7.45	S.G.D.
51.72	4.34	4.52	4.50	16.68	202.0	7.28	S.G.D.
65.22	5.22	3.66	3.08	11.69	171.2	6.89	S.G.D.
65.22	6.13	5.48	5.27	16.61	445.9	9.48	S.G.D.
88.24	6.18	8.94	8.50	--	824.5	11.67	S.L.
68.18	5.45	4.02	3.58	16.22	215.2	7.43	S.G.D.
78.95	7.42	3.34	5.14	--	308.2	8.38	PAR.

3-D BED PROBE POSITION=(6CM,55CM)

SUPERFICIAL GAS VELOCITY=12.46CM/SEC PARTICLE SIZE:250-355

UB	AL	RF	RR	RW	VB	DE	SHAPE
93.75	10.50	5.46	2.10	--	679.2	10.91	S.G.
93.75	8.25	3.36	5.87	16.45	445.9	9.48	P.C.
83.33	7.00	3.42	5.78	16.51	366.9	8.88	P.C.
75.00	10.05	3.34	6.32	16.55	628.7	10.63	P.C.
78.95	6.79	3.37	5.41	16.53	311.6	8.41	P.C.
51.72	5.17	6.78	6.59	--	424.8	9.35	S.L.
88.24	7.94	3.39	5.58	--	388.6	9.05	PAR.
78.95	8.84	3.41	6.00	--	500.0	9.85	PAR.
60.00	5.28	12.67	10.29	--	955.3	12.25	S.L.
71.43	6.00	6.79	6.76	16.57	644.5	10.72	S.G.D.
78.95	6.95	7.64	7.61	--	808.0	11.59	S.L.
75.00	5.40	5.01	4.63	7.80	353.7	8.77	S.G.D.
60.00	5.28	4.13	3.96	--	207.2	7.34	S.G.
83.33	7.67	4.02	1.71	--	271.3	8.03	S.G.
83.33	7.17	3.42	5.46	--	335.1	8.62	PAR.
75.00	7.65	7.80	7.61	16.55	1142.1	12.97	S.G.D.
71.43	5.71	4.15	3.84	--	229.9	7.60	S.G.
51.72	4.97	4.11	4.02	--	190.3	7.14	S.G.
42.86	4.63	5.46	5.46	16.73	305.2	8.35	S.G.D.
88.24	8.12	3.44	5.87	--	439.9	9.44	PAR.
88.24	5.82	6.72	6.66	--	509.4	9.94	S.L.
107.14	6.86	5.68	5.29	16.38	543.6	10.13	S.G.D.
62.50	6.50	3.48	1.58	16.62	174.5	6.93	S.G.D.
60.00	5.52	5.91	5.90	--	390.1	9.09	S.L.
75.00	7.20	6.37	6.06	16.55	719.5	11.12	S.G.D.
78.95	7.42	4.07	2.30	--	275.9	8.08	S.G.
60.00	5.04	4.13	4.02	--	195.2	7.20	S.G.
53.57	6.11	4.02	3.44	--	233.1	7.64	S.G.
93.75	12.37	3.40	7.04	--	962.2	12.25	PAR.
83.33	7.50	4.02	2.03	--	269.5	8.01	S.G.
65.22	6.26	3.49	1.85	8.87	174.7	6.94	S.G.D.
71.43	3.57	6.79	5.98	--	224.3	7.56	S.L.
65.22	5.22	3.49	2.88	16.25	153.8	6.65	S.G.D.
88.24	6.35	6.72	6.71	--	583.9	10.40	S.L.
65.22	5.48	3.41	2.71	--	149.4	6.58	S.G.
60.00	6.00	4.06	3.56	--	232.7	7.63	S.G.
78.95	8.05	3.65	6.77	--	580.6	10.35	PAR.
107.14	9.00	3.59	6.87	--	668.0	10.85	PAR.
78.95	8.84	3.34	5.61	--	437.5	9.42	PAR.

78.95	5.37	4.97	4.58	7.64	346.4	8.71	S.G.D.
78.95	12.32	3.81	4.99	16.53	480.8	9.72	P.C.
65.22	8.87	3.41	6.00	--	501.6	9.86	PAR.
100.00	10.40	3.33	5.25	--	449.7	9.51	PAR.
83.33	9.67	4.57	10.04	16.51	1510.6	14.24	P.C.
83.33	8.17	4.02	7.79	16.51	775.2	11.40	P.C.
88.24	6.00	3.65	2.36	6.72	191.5	7.15	S.G.D.
46.87	3.84	16.45	16.42	16.71	3091.6	18.07	S.G.D.
83.33	7.67	3.32	5.09	--	311.6	8.41	PAR.
51.72	3.72	5.02	4.85	--	164.7	6.82	S.L.
78.95	6.63	3.30	4.46	--	207.2	7.34	PAR.
83.33	8.50	3.54	8.04	9.26	810.0	11.57	P.C.
78.95	8.68	3.41	6.37	16.53	552.1	10.18	P.C.
57.69	4.62	8.10	7.97	16.65	609.4	10.52	S.L.D.
88.24	5.82	6.72	6.66	--	509.4	9.94	S.L.
71.43	6.43	3.59	2.20	--	187.9	7.11	S.G.
44.12	4.85	6.07	6.07	16.72	392.7	9.09	S.L.D.
75.00	7.35	3.30	5.07	16.55	296.7	8.28	P.C.
78.95	8.05	6.33	6.10	--	743.7	11.24	S.G.
75.00	5.55	4.11	3.67	16.55	228.1	7.58	S.G.D.
60.00	7.20	6.78	6.77	--	713.7	11.09	S.G.
42.86	3.86	10.71	10.15	16.73	805.0	11.54	S.L.D.
71.43	5.00	4.59	4.47	16.57	249.5	7.81	S.G.D.
68.18	5.73	3.42	2.53	--	155.8	6.68	S.G.
62.50	4.37	5.88	5.69	--	266.0	8.00	S.L.
78.95	9.79	4.97	1.19	--	513.1	9.93	S.G.
78.95	10.11	5.45	2.84	--	668.6	10.85	S.G.
88.24	8.12	3.50	6.64	16.48	561.1	10.23	P.C.
50.00	4.10	5.49	5.31	--	217.9	7.49	S.L.
88.24	5.47	6.72	6.60	--	460.6	9.61	S.L.
53.57	5.36	5.68	5.67	--	350.9	8.77	S.L.
71.43	4.86	5.05	5.01	15.86	286.6	8.18	S.G.D.
107.14	10.50	3.31	5.82	--	559.5	10.22	PAR.
57.69	4.73	5.47	5.42	--	273.9	8.08	S.L.
62.50	7.00	5.88	5.77	--	546.3	10.14	S.G.
100.00	9.20	7.80	7.67	--	1258.4	13.39	S.G.
68.18	6.14	3.51	2.09	11.18	175.1	6.94	S.G.D.
71.43	7.14	4.59	3.81	--	353.6	8.77	S.G.
55.56	1.78	10.33	8.04	16.66	205.6	7.32	S.L.D.
48.39	3.39	6.98	6.97	8.09	434.8	9.40	S.G.D.
71.43	3.57	8.49	8.46	10.71	603.9	10.49	S.L.D.
62.50	6.50	3.48	1.49	9.26	174.7	6.94	S.G.D.
88.24	5.12	6.72	6.72	16.48	508.6	9.90	S.L.D.
65.22	3.91	5.48	5.45	16.25	241.7	7.73	S.L.D.
68.18	5.59	5.94	5.46	6.94	546.6	10.14	S.G.D.
44.12	2.74	16.72	9.17	--	371.6	8.94	S.L.
100.00	7.60	3.37	5.34	--	340.2	8.66	PAR.
65.22	5.09	7.24	7.10	8.87	717.2	11.11	S.G.D.

78.95	5.68	5.45	5.34	16.53	402.4	9.16	S.G.D.
107.14	5.79	7.33	7.16	--	567.5	10.30	S.L.
60.00	5.16	4.55	4.51	--	236.6	7.67	S.G.
55.56	4.00	10.33	10.17	13.65	927.8	12.10	S.L.D.
88.24	8.12	3.50	3.54	4.07	708.4	11.06	P.C.
60.00	4.44	5.91	5.90	16.63	330.4	8.58	S.L.D.
107.14	11.79	3.43	5.24	--	509.1	9.91	PAR.
75.00	4.80	5.49	5.49	16.55	325.4	8.53	S.G.D.
83.33	6.33	4.57	4.22	--	309.9	8.40	S.G.
53.57	2.68	4.56	4.16	--	82.7	5.42	S.L.
88.24	7.06	5.00	4.26	16.48	433.1	9.39	S.G.D.
57.69	6.23	4.02	3.37	--	237.6	7.68	S.G.
51.72	4.76	5.02	5.01	--	244.4	7.78	S.L.

3-D BED   PROBE POSITION=(0CM,45CM)

SUPERFICIAL GAS VELOCITY=12.46CM/SEC   PARTICLE SIZE:250-355

UB	AL	RF	RR	RW	VB	DE	SHAPE
88.24	10.41	3.44	7.16	16.48	835.0	11.68	P.C.
68.18	7.36	3.35	5.53	16.22	353.0	8.77	P.C.
53.57	2.68	4.99	4.42	--	92.4	5.62	S.L.
78.95	5.37	6.33	6.21	9.73	549.3	10.16	S.G.D.
75.00	6.75	3.37	5.35	16.55	303.4	8.34	P.C.
88.24	12.35	3.44	5.28	7.55	1304.8	13.56	P.C.
62.50	6.50	3.48	1.49	9.26	174.7	6.94	S.G.D.
71.43	6.43	4.15	3.22	15.86	266.3	7.98	S.G.D.
78.95	4.26	9.73	9.39	16.53	771.8	11.38	S.L.D.
71.43	5.71	4.15	3.84	--	229.9	7.60	S.G.
75.00	7.95	3.45	6.27	16.55	490.6	9.79	P.C.
71.43	10.14	3.53	4.86	16.57	376.1	8.96	P.C.
65.22	5.22	4.10	3.49	6.34	227.5	7.57	S.G.D.
75.00	4.65	6.37	6.37	15.14	410.8	9.22	S.L.D.
88.24	10.24	3.44	7.28	12.92	847.1	11.74	P.C.
83.33	8.67	4.12	8.67	16.51	1014.5	12.47	P.C.
68.18	6.68	4.10	3.19	--	262.8	7.95	S.G.
93.75	8.06	8.27	8.05	16.45	1366.6	13.77	S.G.D.
62.50	6.50	3.48	1.58	16.62	174.5	6.93	S.G.D.
88.24	7.76	8.94	8.83	16.48	1519.2	14.26	S.G.D.
83.33	11.17	3.48	6.13	9.26	1142.2	12.97	P.C.
88.24	9.00	8.94	8.94	--	1511.2	14.24	S.G.
83.33	8.50	4.12	8.58	16.51	975.5	12.30	P.C.
83.33	7.83	3.48	6.41	16.51	504.3	9.88	P.C.
65.22	3.91	5.48	5.45	16.25	241.7	7.73	S.L.D.
78.95	5.53	6.33	6.32	16.53	508.9	9.91	S.G.D.
68.18	4.09	5.19	5.19	16.59	234.9	7.66	S.L.D.
78.95	10.42	3.52	7.04	--	810.3	11.57	PAR.
68.18	6.55	3.46	1.58	--	172.4	6.91	S.G.
88.24	12.71	3.44	7.35	--	1077.8	12.72	PAR.
71.43	4.71	6.79	6.76	16.57	458.9	9.57	S.L.D.
78.95	9.00	3.34	6.07	14.37	519.7	9.98	P.C.
68.18	5.18	4.10	3.46	5.94	227.6	7.58	S.G.D.
78.95	5.37	6.33	6.33	16.53	489.1	9.78	S.G.D.
75.00	6.75	3.45	0.88	15.14	171.1	6.89	S.G.D.
75.00	7.95	3.45	6.33	15.14	498.2	9.84	P.C.
53.57	2.46	4.99	4.63	16.67	98.7	5.73	S.L.D.
78.95	8.68	3.41	6.37	16.53	552.1	10.18	P.C.
68.18	4.91	5.94	5.93	16.22	385.8	9.03	S.G.D.
93.75	7.87	8.27	7.27	8.27	1565.0	14.40	S.G.D.

75.00	7.80	3.45	6.26	15.14	479.5	9.71	P.C.
68.18	3.95	5.19	5.18	16.59	223.4	7.53	S.L.D.
88.24	12.35	3.44	8.02	12.92	1237.6	13.32	P.C.
68.18	5.73	3.62	2.95	--	176.8	6.96	S.G.
78.95	4.26	9.73	9.39	16.53	771.8	11.38	S.L.D.
71.43	6.29	5.05	4.67	16.57	391.8	9.08	S.G.D.
78.95	8.53	3.52	6.36	--	542.4	10.12	PAR.
88.24	10.24	3.44	7.09	16.48	806.9	11.55	P.C.
93.75	9.56	8.27	8.17	--	1460.6	14.08	S.G.
57.69	5.19	3.49	3.05	--	149.2	6.58	S.G.
71.43	9.14	3.39	6.00	--	517.0	9.96	PAR.
71.43	4.86	5.68	5.62	--	300.8	8.34	S.L.
78.95	4.74	9.73	8.35	--	574.3	10.34	S.L.
62.50	6.25	3.40	1.67	12.16	162.4	6.77	S.G.D.
83.33	7.83	3.42	5.11	7.22	554.4	10.19	P.C.
60.00	5.28	4.13	3.81	16.63	218.1	7.47	S.G.D.
83.33	8.50	3.54	8.04	9.26	810.0	11.57	P.C.
71.43	5.00	5.68	5.67	16.57	364.9	8.87	S.G.D.
78.95	8.84	3.41	6.00	--	500.0	9.85	PAR.
68.18	3.95	5.19	5.18	16.59	223.4	7.53	S.L.D.
83.33	9.00	3.48	6.87	16.51	666.2	10.84	P.C.
75.00	7.50	3.30	4.85	16.55	276.7	8.08	P.C.
78.95	7.58	3.58	6.97	14.37	575.8	10.32	P.C.
65.22	5.61	4.06	3.49	11.69	228.3	7.58	S.G.D.
78.95	4.26	9.73	9.39	16.53	771.8	11.38	S.L.D.
68.18	7.36	3.35	5.52	16.59	351.9	8.76	P.C.
78.95	9.63	3.37	6.45	16.53	627.8	10.62	P.C.
88.24	9.71	3.57	7.04	--	754.7	11.30	PAR.
71.43	7.29	3.36	5.20	--	309.0	8.39	PAR.
62.50	4.62	3.52	3.35	--	133.2	6.34	S.G.
78.95	8.05	6.33	5.71	16.53	803.2	11.53	S.G.D.
71.43	4.71	5.68	5.68	15.86	338.4	8.65	S.G.D.
93.75	5.62	12.16	12.10	16.45	1897.8	15.36	S.L.D.
71.43	10.29	3.53	4.73	--	361.0	8.83	PAR.
75.00	6.15	3.55	2.23	15.14	180.1	7.01	S.G.D.
65.22	5.22	4.10	3.49	6.34	227.5	7.57	S.G.D.
78.95	4.74	5.45	5.41	--	273.0	8.07	S.L.
71.43	4.71	5.68	5.60	--	286.7	8.20	S.L.
75.00	7.20	3.55	6.89	16.55	535.0	10.07	P.C.
57.69	4.38	4.09	4.08	--	158.7	6.72	S.G.
78.95	5.37	6.33	6.21	9.73	549.3	10.16	S.G.D.
68.18	6.55	4.02	2.91	16.59	252.1	7.84	S.G.D.
88.24	9.18	3.44	6.24	--	562.2	10.24	PAR.
65.22	4.83	4.84	4.73	11.69	272.8	8.05	S.G.D.
68.18	5.73	3.62	2.95	--	176.8	6.96	S.G.
78.95	9.63	3.34	6.22	16.53	583.6	10.37	P.C.

83.33	9.83	3.38	6.68	13.65	687.2	10.95	P.C.
78.95	4.74	6.33	6.13	---	335.3	8.64	S.L.
68.18	4.50	6.94	6.87	16.59	444.8	9.47	S.L.D.
83.33	7.83	3.48	7.07	9.26	597.2	10.45	P.C.
62.50	6.00	3.52	2.16	7.65	175.5	6.95	S.G.D.
78.95	9.00	3.34	5.66	---	453.3	9.53	PAR.
68.18	6.14	4.02	3.21	16.59	240.0	7.71	S.G.D.
65.22	4.83	4.84	4.19	4.84	325.0	8.53	S.G.D.
78.95	9.79	4.97	1.19	---	513.1	9.93	S.G.
78.95	4.89	9.73	9.56	16.53	950.2	12.20	S.L.D.
60.00	6.96	3.55	1.02	---	187.8	7.11	S.G.
71.43	6.29	4.59	4.02	15.86	324.0	8.52	S.G.D.
78.95	4.89	9.73	9.66	14.37	1027.4	12.52	S.L.D.
88.24	8.12	3.50	3.54	4.07	708.4	11.06	P.C.

3-D BED PROBE POSITION=(2CM,45CM)

SUPERFICIAL GAS VELOCITY=12.46CM/SEC PARTICLE SIZE:250-355

UB	AL	RF	RR	RW	VB	DE	SHAPE
83.33	8.00	3.38	5.55	--	387.8	9.05	PAR.
71.43	4.86	5.68	5.62	--	300.8	8.34	S.L.
62.50	6.75	7.65	7.60	--	773.3	11.42	S.L.
71.43	10.43	4.15	3.15	3.30	1742.7	14.93	P.C.
68.18	6.00	3.46	2.36	--	165.5	6.81	S.G.
62.50	6.12	4.56	4.06	16.28	312.1	8.42	S.G.D.
65.22	7.17	5.48	5.21	--	499.7	9.85	S.G.
55.56	4.44	4.61	4.58	16.66	215.5	7.44	S.G.D.
78.95	7.58	3.58	6.27	--	467.5	9.63	PAR.
68.18	2.32	6.94	5.99	16.59	151.2	6.61	S.L.D.
75.00	11.40	3.55	5.40	7.80	1341.8	13.68	P.C.
71.43	10.29	4.15	3.15	3.30	1702.9	14.82	P.C.
65.22	4.17	7.24	7.21	8.87	570.0	10.29	S.G.D.
65.22	5.61	4.06	3.75	--	216.5	7.45	S.G.
65.22	5.48	3.49	2.57	8.87	162.2	6.77	S.G.D.
78.95	5.68	3.52	2.60	16.53	167.1	6.83	S.G.D.
83.33	6.83	3.61	1.49	16.51	195.9	7.21	S.G.D.
46.87	3.66	4.54	4.45	--	139.3	6.45	S.L.
53.57	4.29	10.71	10.35	16.38	960.7	12.24	S.L.D.
83.33	2.33	4.57	4.25	16.51	78.8	5.32	S.L.D.
53.57	2.68	4.56	4.16	--	82.7	5.42	S.L.
62.50	5.00	9.26	8.22	--	596.0	10.47	S.L.
40.54	5.03	5.50	5.48	--	303.6	8.36	S.L.
57.69	5.77	6.32	6.29	--	459.4	9.60	S.L.
71.43	5.57	4.06	3.77	--	215.2	7.44	S.G.
68.18	6.68	4.02	2.80	16.59	255.6	7.87	S.G.D.
53.57	3.21	16.67	16.59	16.67	2797.5	17.48	S.G.D.
71.43	5.86	4.59	4.41	--	283.9	8.15	S.G.
60.00	4.92	5.91	5.83	--	325.1	8.55	S.L.
68.18	5.59	4.53	4.23	16.59	278.6	8.10	S.G.D.
44.12	3.79	6.72	6.53	16.72	323.2	8.51	S.L.D.
68.18	3.95	5.19	5.18	16.59	223.4	7.53	S.L.D.
75.00	6.75	4.11	2.89	15.14	270.4	8.02	S.G.D.
78.95	4.26	9.73	8.05	--	474.2	9.70	S.L.
60.00	5.40	4.06	3.83	--	206.8	7.34	S.G.
68.18	6.68	4.10	3.19	--	262.8	7.95	S.G.
78.95	7.74	3.58	6.33	--	487.2	9.76	PAR.
55.56	3.56	4.61	4.49	--	136.0	6.40	S.L.
78.95	4.74	4.07	4.01	--	175.5	6.95	S.G.
93.75	8.06	3.52	6.22	--	490.1	9.78	PAR.

50.00	5.30	6.80	6.27	6.80	731.9	11.18	S.G.D.
42.86	3.51	9.00	8.42	16.49	488.6	9.77	S.L.D.
71.43	4.71	5.68	5.60	--	286.7	8.20	S.L.
78.95	4.74	5.45	5.41	--	273.0	8.07	S.L.
78.95	5.37	9.73	9.65	16.53	1087.6	12.76	S.L.D.
83.33	7.33	7.22	7.22	--	807.0	11.55	S.G.
62.50	5.25	7.65	7.64	16.28	668.8	10.85	S.L.D.
71.43	7.29	5.68	3.80	4.06	663.5	10.82	S.G.D.
75.00	6.75	4.11	2.91	16.55	270.0	8.02	S.G.D.
68.18	4.64	5.94	5.79	--	296.4	8.30	S.L.
57.69	4.04	9.98	8.02	--	442.5	9.48	S.L.
57.69	3.58	8.10	7.65	16.65	409.6	9.21	S.L.D.
88.24	8.82	3.30	5.40	16.48	404.4	9.17	P.C.
78.95	8.53	3.52	6.36	--	542.4	10.12	PAR.
107.14	11.14	7.33	5.55	16.38	1468.0	14.10	S.G.D.
55.56	5.44	3.61	2.94	16.66	171.3	6.89	S.G.D.
68.18	5.59	4.02	3.52	16.22	220.6	7.50	S.G.D.
71.43	6.29	4.59	4.26	--	309.3	8.39	S.G.
107.14	9.00	3.33	5.16	7.33	586.7	10.39	P.C.
48.39	2.90	6.20	5.25	--	138.6	6.44	S.L.
71.43	7.29	3.48	5.73	--	375.2	8.95	PAR.
75.00	6.15	3.55	2.23	15.14	180.1	7.01	S.G.D.
51.72	4.76	14.63	10.80	--	927.6	12.13	S.L.
48.39	4.06	11.82	8.92	--	542.9	10.15	S.L.
68.18	6.41	4.98	4.77	--	366.7	8.88	S.G.
60.00	6.96	3.55	1.02	--	187.8	7.11	S.G.
78.95	8.21	3.46	6.46	16.53	537.5	10.09	P.C.
65.22	5.87	5.48	5.47	--	381.5	9.00	S.G.
53.57	2.68	4.99	4.42	--	92.4	5.62	S.L.
93.75	9.56	3.33	5.27	16.45	417.5	9.27	P.C.
60.00	3.60	12.67	12.05	16.63	1102.5	12.82	S.L.D.
75.00	7.65	7.80	7.61	16.55	1142.1	12.97	S.G.D.
88.24	12.71	3.57	8.05	--	1293.3	13.52	PAR.
83.33	6.33	4.02	3.03	13.65	247.0	7.78	S.G.D.
65.22	7.70	3.60	6.39	--	493.8	9.81	PAR.
65.22	5.09	16.25	16.17	16.61	3988.8	19.68	S.G.D.
65.22	5.22	4.10	3.49	6.34	227.5	7.57	S.G.D.
75.00	7.05	3.55	0.58	15.14	188.0	7.11	S.G.D.
68.18	6.95	4.10	2.61	11.18	275.1	8.07	S.G.D.
75.00	4.65	6.37	6.22	7.80	511.2	9.92	S.G.D.
100.00	11.80	3.30	5.95	--	656.2	10.78	PAR.
78.95	8.84	3.34	5.61	--	437.5	9.42	PAR.
68.18	6.68	4.10	3.19	--	262.8	7.95	S.G.
57.69	2.31	13.14	11.65	16.65	619.9	10.58	S.L.D.
71.43	5.14	3.39	2.91	--	139.4	6.43	S.G.
57.69	5.65	8.10	7.72	--	624.0	10.63	S.L.
78.95	7.42	3.46	5.32	7.64	530.6	10.04	P.C.
55.56	6.78	3.61	1.74	--	195.1	7.20	S.G.

93.75	10.69	5.46	1.38	16.45	681.4	10.92	S.G.D.
100.00	7.00	3.42	5.35	--	314.9	8.44	PAR.
75.00	9.30	5.01	2.59	--	518.8	9.97	S.G.
57.69	3.46	6.85	6.54	16.65	288.9	8.20	S.L.D.
93.75	9.37	3.36	5.88	--	509.8	9.91	PAR.
53.57	5.57	4.15	3.89	--	223.2	7.53	S.G.
78.95	9.00	3.34	5.66	--	453.3	9.53	PAR.
71.43	5.00	5.05	4.83	8.49	325.9	8.54	S.G.D.
78.95	7.58	3.58	6.27	--	467.5	9.63	PAR.
83.33	9.50	3.38	6.46	16.51	621.4	10.59	P.C.
78.95	5.05	9.73	8.53	--	645.0	10.75	S.L.
68.18	4.50	4.53	4.53	--	192.8	7.19	S.L.

3-D BED PROBE POSITION=(4CM,45CM)

SUPERFICIAL GAS VELOCITY=12.46CM/SEC PARTICLE SIZE:250-355

UB	AL	RF	RR	RW	VB	DE	SHAPE
62.50	6.50	3.48	1.54	12.16	174.6	6.93	S.G.D.
100.00	12.80	3.64	5.12	--	526.4	10.02	PAR.
78.95	7.74	3.58	6.33	--	487.2	9.76	PAR.
88.24	10.41	3.44	7.16	16.48	835.0	11.68	P.C.
83.33	9.17	7.22	6.45	16.51	1199.2	13.18	S.G.D.
83.33	10.33	3.54	7.12	--	823.4	11.63	PAR.
57.69	3.46	6.32	5.63	--	194.3	7.21	S.L.
65.22	6.26	3.49	1.97	16.25	174.1	6.93	S.G.D.
57.69	6.46	3.58	2.13	--	187.5	7.10	S.G.
50.00	4.00	11.43	8.69	--	507.7	9.92	S.L.
78.95	11.53	3.30	6.04	--	660.9	10.81	PAR.
65.22	5.35	4.06	3.85	--	204.7	7.31	S.G.
44.12	2.74	8.94	7.92	16.24	322.9	8.51	S.L.D.
65.22	8.74	3.49	6.34	--	551.8	10.18	PAR.
38.46	4.31	8.61	8.59	11.90	739.0	11.22	S.L.D.
55.56	5.78	4.00	3.58	--	217.1	7.46	S.G.
65.22	4.70	4.84	4.83	--	226.5	7.58	S.L.
71.43	13.00	3.59	8.26	--	1393.7	13.86	PAR.
75.00	6.45	3.55	2.06	--	183.4	7.05	S.G.
55.56	1.56	13.65	11.47	16.35	395.2	9.10	S.L.D.
71.43	7.14	3.59	0.52	--	193.8	7.18	S.G.
100.00	8.60	3.33	5.78	16.41	450.7	9.51	P.C.
65.22	5.35	4.57	4.50	--	250.1	7.82	S.G.
78.95	8.68	3.41	5.95	--	482.3	9.73	PAR.
71.43	8.29	3.48	6.59	16.57	564.0	10.25	P.C.
65.22	6.00	3.41	2.06	16.61	160.5	6.74	S.G.D.
68.18	6.68	4.02	2.80	16.59	255.6	7.87	S.G.D.
71.43	5.00	4.59	4.47	16.57	249.5	7.81	S.G.D.
53.57	3.86	4.08	4.08	--	130.8	6.32	S.L.
83.33	8.50	4.12	8.58	16.51	975.5	12.30	P.C.
65.22	7.57	3.35	4.40	--	229.7	7.60	PAR.
65.22	5.87	3.45	2.29	16.61	163.1	6.78	S.G.D.
55.56	2.44	10.33	6.67	--	178.5	7.01	S.L.
83.33	8.83	3.42	6.06	--	509.1	9.91	PAR.
71.43	6.00	4.06	2.76	4.15	254.5	7.86	S.G.D.
75.00	7.20	3.55	6.89	16.55	535.0	10.07	P.C.
78.95	8.84	3.34	5.61	--	437.5	9.42	PAR.
46.87	3.19	8.27	7.64	16.19	358.2	8.81	S.L.D.
88.24	9.71	3.57	7.04	--	754.7	11.30	PAR.
88.24	8.12	3.35	5.78	16.48	425.1	9.33	P.C.

88.24	12.71	3.44	7.35	--	1077.8	12.72	PAR.
68.18	6.00	3.31	1.94	--	148.6	6.57	S.G.
78.95	7.58	3.58	6.85	16.53	557.6	10.21	P.C.
93.75	6.94	3.46	5.50	--	329.9	8.57	PAR.
75.00	7.95	3.45	6.33	15.14	498.2	9.84	P.C.
75.00	4.50	6.37	6.25	7.80	492.9	9.80	S.G.D.
93.75	5.25	16.45	12.05	--	1272.8	13.48	S.L.
71.43	8.14	3.48	7.61	8.49	685.3	10.94	P.C.
68.18	5.73	3.42	2.53	--	155.8	6.68	S.G.
93.75	7.50	8.27	8.15	16.45	1250.5	13.37	S.G.D.
51.72	5.17	3.62	3.26	--	159.0	6.72	S.G.
93.75	9.56	3.52	4.23	5.46	948.7	12.19	P.C.
100.00	4.60	7.80	7.11	--	416.5	9.29	S.L.
93.75	5.62	12.16	10.25	--	1022.2	12.53	S.L.
48.39	3.87	6.20	6.20	9.55	349.7	8.74	S.L.D.
71.43	4.71	5.68	5.60	--	286.7	8.20	S.L.
78.95	7.11	3.37	5.60	14.37	348.7	8.73	P.C.
44.12	3.79	5.54	5.26	--	193.6	7.20	S.L.
68.18	6.00	3.46	2.36	--	165.5	6.81	S.G.
46.87	2.44	4.88	4.53	16.45	93.8	5.64	S.L.D.
78.95	8.21	3.30	4.84	--	301.8	8.32	PAR.
78.95	5.21	6.33	6.33	16.53	469.2	9.64	S.G.D.
65.22	4.96	4.10	3.88	16.25	200.9	7.27	S.G.D.
62.50	5.25	3.57	3.16	--	158.0	6.71	S.G.
78.95	8.21	3.46	6.46	16.53	537.5	10.09	P.C.
68.18	3.95	5.19	5.18	16.59	223.4	7.53	S.L.D.
60.00	3.96	3.43	3.32	16.63	109.8	5.94	S.G.D.
71.43	4.57	5.68	5.57	--	272.7	8.07	S.L.
65.22	2.48	16.61	8.73	--	304.5	8.37	S.L.
53.57	6.43	4.99	4.78	--	370.0	8.91	S.G.
100.00	11.80	3.30	5.95	--	656.2	10.78	PAR.
83.33	8.00	3.32	4.65	--	271.4	8.03	PAR.
75.00	7.05	3.55	0.58	15.14	188.0	7.11	S.G.D.
68.18	6.95	4.10	2.61	11.18	275.1	8.07	S.G.D.
53.57	2.68	4.56	4.16	--	82.7	5.42	S.L.
53.57	4.82	6.37	6.18	--	348.2	8.75	S.L.
68.18	6.68	4.10	3.19	--	262.8	7.95	S.G.
65.22	9.00	3.49	6.96	16.61	682.8	10.93	P.C.
78.95	8.84	3.34	5.61	--	437.5	9.42	PAR.
71.43	4.71	5.68	5.60	--	286.7	8.20	S.L.
78.95	7.42	3.46	5.32	7.64	530.6	10.04	P.C.
55.56	6.78	3.61	1.74	--	195.1	7.20	S.G.
93.75	10.69	5.46	1.38	16.45	681.4	10.92	S.G.D.
65.22	6.26	3.49	1.97	16.25	174.1	6.93	S.G.D.
75.00	4.65	6.37	6.37	15.14	410.8	9.22	S.L.D.
57.69	3.46	6.85	6.54	16.65	288.9	8.20	S.L.D.
93.75	9.37	3.36	5.88	--	509.8	9.91	PAR.
53.57	5.57	4.15	3.89	--	223.2	7.53	S.G.

75.00	7.35	4.55	2.59	4.02	375.0	8.95	S.G.D.
71.43	5.00	5.05	4.83	8.49	325.9	8.54	S.G.D.
68.18	4.64	5.94	5.79	--	296.4	8.30	S.L.
71.43	7.29	3.36	5.20	--	309.0	8.39	PAR.
78.95	8.68	3.41	5.95	--	482.3	9.73	PAR.
100.00	11.40	3.33	6.66	16.41	792.7	11.48	P.C.
55.56	1.56	13.65	11.47	16.35	395.2	9.10	S.L.D.
75.00	4.50	6.37	6.25	7.80	492.9	9.80	S.G.D.
115.38	4.85	6.85	6.41	6.85	684.7	10.94	S.G.D.
78.95	7.74	3.58	6.33	--	487.2	9.76	PAR.
75.00	11.40	3.55	5.40	7.80	1341.8	13.68	P.C.
75.00	4.65	6.37	6.22	7.80	511.2	9.92	S.G.D.

3-D BED PROBE POSITION=(6CM,45CM)

SUPERFICIAL GAS VELOCITY=12.46CM/SEC PARTICLE SIZE:250-355

UB	AL	RF	RR	RW	VB	DE	SHAPE
71.43	4.71	5.68	5.60	--	286.7	8.20	S.L.
75.00	4.65	6.37	6.22	7.80	511.2	9.92	S.G.D.
88.24	9.71	3.35	6.86	8.94	699.9	11.02	P.C.
75.00	7.50	3.30	4.85	16.55	276.7	8.08	P.C.
57.69	5.31	13.14	12.87	13.14	2838.8	17.57	S.G.D.
78.95	8.84	3.34	5.61	--	437.5	9.42	PAR.
53.57	2.68	4.56	4.16	--	82.7	5.42	S.L.
65.22	4.83	4.84	4.84	--	236.1	7.69	S.L.
75.00	4.65	6.37	6.37	15.14	410.8	9.22	S.L.D.
78.95	6.63	3.41	1.13	--	166.0	6.82	S.G.
75.00	6.00	3.55	2.58	--	175.6	6.95	S.G.
78.95	5.21	6.33	6.33	16.53	469.2	9.64	S.G.D.
57.69	4.85	4.09	3.90	16.65	194.2	7.19	S.G.D.
60.00	4.08	4.06	4.06	--	141.1	6.46	S.G.
71.43	6.43	4.59	3.96	16.57	330.6	8.58	S.G.D.
88.24	7.41	3.57	6.15	--	440.1	9.44	PAR.
40.54	3.16	4.54	4.47	16.74	127.3	6.24	S.L.D.
71.43	6.43	3.66	2.20	16.57	197.6	7.23	S.G.D.
65.22	3.52	3.60	3.60	--	94.5	5.67	S.L.
83.33	8.00	4.02	0.63	--	273.1	8.05	S.G.
71.43	5.86	3.66	2.72	15.86	186.7	7.09	S.G.D.
53.57	3.75	14.16	9.60	--	570.2	10.32	S.L.
62.50	5.00	4.56	4.44	16.62	247.1	7.79	S.G.D.
88.24	7.41	3.39	5.76	16.48	385.4	9.03	P.C.
44.12	4.68	4.07	3.93	16.72	184.7	7.07	S.G.D.
71.43	7.71	5.05	3.95	16.57	476.7	9.69	S.G.D.
88.24	4.59	5.54	5.46	--	265.6	8.00	S.L.
55.56	3.67	5.05	4.86	--	161.6	6.78	S.L.
68.18	6.55	4.10	3.06	16.59	263.1	7.95	S.G.D.
50.00	4.70	6.80	6.77	16.69	457.9	9.56	S.L.D.
78.95	4.74	5.45	5.41	--	273.0	8.07	S.L.
53.57	4.07	4.99	4.98	10.71	235.9	7.67	S.G.D.
57.69	4.96	3.63	3.24	16.65	158.9	6.72	S.G.D.
60.00	6.96	3.55	1.02	--	187.8	7.11	S.G.
78.95	7.74	3.58	6.33	--	487.2	9.76	PAR.
78.95	6.32	9.73	9.11	--	955.1	12.25	S.L.
107.14	13.07	3.33	7.18	16.38	1056.1	12.63	P.C.
68.18	6.68	3.62	1.79	16.59	196.6	7.21	S.G.D.
75.00	6.75	4.11	2.91	16.55	270.0	8.02	S.G.D.
93.75	11.44	3.46	7.06	--	896.7	11.96	PAR.

50.00	4.30	6.80	6.33	--	312.0	8.44	S.L.
75.00	4.35	4.11	4.10	--	158.0	6.71	S.G.
68.18	4.50	4.53	4.53	--	192.8	7.19	S.L.
71.43	5.29	4.15	3.73	10.71	226.0	7.56	S.G.D.
71.43	5.57	3.59	2.99	--	169.0	6.86	S.G.
60.00	3.72	6.78	6.68	12.67	350.6	8.75	S.L.D.
62.50	5.50	5.88	5.84	16.62	442.2	9.45	S.G.D.
83.33	6.33	4.12	3.07	9.26	262.9	7.95	S.G.D.
34.88	3.35	4.01	3.95	--	101.8	5.81	S.L.
83.33	10.50	3.32	5.56	16.51	510.1	9.91	P.C.
71.43	6.43	4.59	4.20	--	317.3	8.46	S.G.
65.22	5.87	4.84	4.54	16.61	333.7	8.61	S.G.D.
71.43	7.29	3.39	5.36	--	328.3	8.56	PAR.
75.00	6.30	3.55	2.09	16.55	182.4	7.04	S.G.D.
68.18	5.05	4.02	3.89	--	187.4	7.10	S.G.
75.00	6.45	3.32	1.09	--	152.5	6.63	S.G.
50.00	4.30	4.14	4.13	--	157.1	6.69	S.G.
88.24	6.18	3.65	2.39	12.92	192.8	7.17	S.G.D.
88.24	9.18	3.32	4.96	--	355.0	8.79	PAR.
53.57	2.79	4.99	4.76	16.38	121.4	6.14	S.L.D.
68.18	5.86	3.62	2.67	16.59	183.2	7.05	S.G.D.
68.18	5.45	3.38	2.68	--	146.4	6.54	S.G.
78.95	5.53	6.33	6.28	--	431.1	9.40	S.L.
68.18	4.50	4.10	4.08	--	165.5	6.81	S.G.
53.57	2.68	4.99	4.42	--	92.4	5.62	S.L.
68.18	3.95	5.19	5.18	16.59	223.4	7.53	S.L.D.
71.43	5.57	4.06	3.77	--	215.2	7.44	S.G.
57.69	5.08	13.14	13.01	16.65	1986.2	15.60	S.L.D.
53.57	3.54	16.38	10.16	--	596.8	10.47	S.L.
68.18	4.50	6.94	6.87	16.59	444.8	9.47	S.L.D.
65.22	7.17	3.49	5.74	--	371.9	8.92	PAR.
78.95	7.58	3.58	6.27	--	467.5	9.63	PAR.
65.22	3.91	4.10	3.93	6.34	170.5	6.88	S.G.D.
78.95	5.37	9.73	8.70	--	718.6	11.14	S.L.
51.72	4.55	6.78	6.40	--	342.4	8.70	S.L.
88.24	7.76	3.39	4.34	--	230.0	7.60	PAR.
88.24	7.59	5.54	4.71	12.92	582.5	10.36	S.G.D.
53.57	4.39	6.37	6.33	16.67	369.8	8.91	S.L.D.
65.22	3.52	3.60	3.60	--	94.5	5.67	S.L.
71.43	5.43	3.53	2.72	10.71	164.3	6.80	S.G.D.
65.22	4.04	7.24	6.49	--	302.5	8.35	S.L.
78.95	6.47	3.32	1.03	--	152.8	6.63	S.G.
83.33	7.83	3.48	6.41	16.51	504.3	9.88	P.C.
78.95	8.53	3.52	6.36	--	542.4	10.12	PAR.
62.50	5.25	4.02	3.67	16.28	206.7	7.34	S.G.D.
57.69	5.77	5.47	5.47	--	371.2	8.92	S.G.
62.50	5.25	3.52	3.07	--	153.6	6.65	S.G.
78.95	8.05	6.33	6.10	--	743.7	11.24	S.G.

75.00	8.70	4.02	7.22	---	713.4	11.09	PAR.
71.43	6.29	3.36	1.52	16.57	157.2	6.70	S.G.D.
55.56	1.78	10.33	5.79	---	96.6	5.71	S.L.
60.00	5.04	6.78	6.71	9.60	591.7	10.42	S.G.D.
88.24	8.47	3.57	4.27	5.54	818.1	11.60	P.C.
83.33	7.50	3.31	4.88	---	280.7	8.12	PAR.
65.22	4.57	7.24	7.24	11.69	552.6	10.18	S.L.D.
57.69	4.73	4.50	4.50	---	205.7	7.32	S.G.
57.69	4.85	6.85	6.85	13.14	516.2	9.95	S.L.D.
51.72	5.48	5.47	5.47	---	343.6	8.69	S.G.
55.56	3.56	4.61	4.59	16.66	156.4	6.68	S.L.D.
75.00	6.75	4.11	2.91	16.55	270.0	8.02	S.G.D.

3-D BED   PROBE POSITION=(8CM,45CM)

SUPERFICIAL GAS VELOCITY=12.46CM/SEC   PARTICLE SIZE:250-355

UB	AL	RF	RR	RW	VB	DE	SHAPE
57.69	4.04	3.63	3.61	--	117.2	6.07	S.G.
68.18	6.41	4.02	2.92	11.22	250.1	7.82	S.G.D.
60.00	6.96	3.55	1.02	--	187.8	7.11	S.G.
78.95	7.74	3.58	6.33	--	487.2	9.76	PAR.
83.33	7.67	3.48	6.47	13.65	501.5	9.86	P.C.
65.22	5.22	3.49	2.88	16.25	153.8	6.65	S.G.D.
78.95	8.53	3.41	6.39	14.37	544.9	10.13	P.C.
68.18	3.95	5.19	5.18	16.59	223.4	7.53	S.L.D.
78.95	8.84	3.34	6.02	14.37	501.6	9.86	P.C.
78.95	9.63	3.41	6.71	16.53	679.4	10.91	P.C.
53.57	2.68	4.99	4.42	--	92.4	5.62	S.L.
78.95	5.21	6.33	6.06	7.64	574.2	10.31	S.G.D.
62.50	4.62	3.57	3.30	16.62	142.7	6.48	S.G.D.
78.95	8.21	3.58	7.14	16.53	654.8	10.77	P.C.
65.22	5.87	3.60	2.54	11.69	181.1	7.02	S.G.D.
83.33	9.00	3.48	6.87	16.51	666.2	10.84	P.C.
65.22	4.57	4.06	4.03	--	166.2	6.82	S.G.
83.33	9.33	3.61	7.81	16.51	890.5	11.94	P.C.
68.18	4.09	5.19	5.19	16.22	235.7	7.66	S.L.D.
83.33	8.67	4.12	8.67	16.51	1014.5	12.47	P.C.
75.00	6.15	3.55	2.23	15.14	180.1	7.01	S.G.D.
88.24	12.71	3.44	7.35	--	1077.8	12.72	PAR.
78.95	8.84	3.34	5.61	--	437.5	9.42	PAR.
78.95	9.47	4.97	2.09	--	510.2	9.91	S.G.
68.18	6.68	4.02	2.80	16.59	255.6	7.87	S.G.D.
65.22	3.91	5.48	5.45	16.25	241.7	7.73	S.L.D.
62.50	6.00	3.52	2.16	7.65	175.5	6.95	S.G.D.
78.95	8.68	3.41	6.37	16.53	552.1	10.18	P.C.
75.00	6.75	3.55	1.41	15.14	186.9	7.09	S.G.D.
65.22	5.61	4.06	3.75	--	216.5	7.45	S.G.
88.24	9.00	3.44	6.65	16.48	623.5	10.60	P.C.
53.57	2.57	4.99	4.68	16.38	106.4	5.88	S.L.D.
78.95	4.89	9.73	9.56	16.53	950.2	12.20	S.L.D.
75.00	4.65	6.37	6.37	15.14	410.8	9.22	S.L.D.
71.43	7.00	3.66	1.34	16.57	203.6	7.30	S.G.D.
78.95	7.42	3.58	5.32	7.64	645.5	10.72	P.C.
53.57	2.89	4.99	4.79	16.67	128.6	6.26	S.L.D.
65.22	5.61	4.06	3.56	16.25	225.3	7.55	S.G.D.
68.18	6.68	4.10	3.19	--	262.8	7.95	S.G.
62.50	5.75	3.52	2.38	7.65	171.4	6.89	S.G.D.
65.22	5.22	4.10	3.49	6.34	227.5	7.57	S.G.D.

83.33	9.00	3.48	7.02	13.65	692.3	10.98	P.C.
68.18	6.14	3.51	2.33	--	173.4	6.92	S.G.
78.95	7.11	3.58	0.49	5.45	192.3	7.16	S.G.D.
88.24	10.24	3.44	7.09	16.48	806.9	11.55	P.C.
57.69	5.19	3.54	2.97	16.65	157.0	6.69	S.G.D.
75.00	7.95	3.45	6.27	16.55	490.6	9.79	P.C.
83.33	9.33	3.61	7.81	16.51	890.5	11.94	P.C.
88.24	6.71	8.94	8.85	12.92	1359.3	13.74	S.G.D.
78.95	5.53	6.33	6.32	16.53	508.9	9.91	S.G.D.
62.50	6.12	3.33	1.66	16.28	151.8	6.62	S.G.D.
71.43	4.71	5.68	5.60	--	286.7	8.20	S.L.
71.43	7.00	3.43	5.84	15.86	374.0	8.94	P.C.
65.22	3.52	3.60	3.60	--	94.5	5.67	S.L.
65.22	4.83	6.34	5.86	6.34	580.4	10.35	S.G.D.
68.18	6.55	3.46	1.58	--	172.4	6.91	S.G.
68.18	4.23	5.19	5.10	--	212.4	7.42	S.L.
68.18	4.50	5.19	5.15	--	234.9	7.68	S.L.
75.00	6.75	3.45	0.88	15.14	171.1	6.89	S.G.D.
60.00	6.72	4.06	2.83	16.63	261.4	7.93	S.G.D.
68.18	6.55	4.02	2.81	11.18	253.6	7.85	S.G.D.
71.43	6.43	4.59	3.94	15.86	331.1	8.58	S.G.D.
53.57	2.57	4.99	4.73	14.16	110.2	5.95	S.L.D.
75.00	6.75	4.11	2.91	16.55	270.0	8.02	S.G.D.
68.18	6.27	4.10	3.48	--	248.4	7.80	S.G.
68.18	4.77	5.94	5.93	16.59	369.3	8.90	S.L.D.
65.22	5.35	3.41	2.81	--	146.3	6.54	S.G.
71.43	7.29	3.43	5.53	--	350.2	8.75	PAR.
75.00	7.20	5.01	3.26	4.11	476.3	9.69	S.G.D.
68.18	4.50	5.19	5.19	16.22	270.4	8.02	S.G.D.
71.43	5.86	5.05	4.81	16.57	361.5	8.84	S.G.D.
78.95	9.47	4.97	2.09	--	510.2	9.91	S.G.
55.56	4.67	4.00	3.94	--	166.9	6.83	S.G.
75.00	9.30	5.01	2.59	--	518.8	9.97	S.G.
78.95	4.74	6.33	6.33	16.53	409.5	9.21	S.L.D.
62.50	6.50	3.40	1.21	9.26	164.2	6.79	S.G.D.
71.43	4.86	5.68	5.67	15.86	352.8	8.77	S.G.D.
68.18	6.55	4.10	3.06	16.59	263.1	7.95	S.G.D.
75.00	4.65	6.37	6.36	10.24	458.7	9.57	S.G.D.
68.18	3.82	5.19	5.17	16.22	212.8	7.41	S.L.D.
71.43	4.57	6.79	6.74	16.57	438.4	9.43	S.L.D.
60.00	6.00	3.51	2.47	--	170.5	6.88	S.G.
71.43	6.43	5.05	4.86	--	377.1	8.96	S.G.
62.50	5.75	3.44	2.38	16.62	159.7	6.73	S.G.D.
60.00	6.96	3.99	2.67	--	254.6	7.86	S.G.
71.43	4.29	8.49	7.38	--	407.6	9.22	S.L.
68.18	6.41	4.10	3.16	16.59	259.0	7.91	S.G.D.
75.00	6.75	4.11	2.89	15.14	270.4	8.02	S.G.D.
53.57	2.46	4.99	4.63	16.38	99.1	5.74	S.L.D.

78.95	9.79	4.97	1.19	--	513.1	9.93	S.G.
65.22	5.22	3.66	3.15	16.25	169.4	6.86	S.G.D.
78.95	4.26	9.73	9.39	16.53	771.8	11.38	S.L.D.
65.22	5.48	4.06	3.55	11.69	223.2	7.53	S.G.D.
51.72	2.79	5.02	4.78	16.68	122.5	6.16	S.L.D.
71.43	10.00	3.53	4.93	10.71	381.4	9.00	P.C.
65.22	4.17	5.48	5.32	--	223.9	7.55	S.L.
71.43	4.71	5.68	5.64	10.71	365.7	8.87	S.G.D.
83.33	9.17	5.92	4.15	9.26	794.2	11.49	S.G.D.
83.33	8.50	3.54	8.04	9.26	810.0	11.57	P.C.
62.50	6.12	3.33	1.80	--	151.3	6.61	S.G.

3-D BED   PROBE POSITION=(0CM,35CM)

SUPERFICIAL GAS VELOCITY=12.46CM/SEC   PARTICLE SIZE:250-355

UB	AL	RF	RR	RW	VB	DE	SHAPE
60.00	4.92	4.13	4.05	--	189.1	7.12	S.G.
60.00	5.52	5.44	5.35	16.31	386.8	9.04	S.G.D.
57.69	3.46	4.58	4.56	16.33	149.0	6.58	S.L.D.
65.22	4.83	5.48	5.24	7.24	388.1	9.05	S.G.D.
65.22	5.09	4.84	4.39	6.34	320.0	8.49	S.G.D.
75.00	7.50	4.02	1.84	16.55	270.1	8.02	S.G.D.
53.57	4.50	3.55	3.30	16.67	136.2	6.38	S.G.D.
60.00	4.92	4.99	4.99	--	254.5	7.88	S.L.
65.22	4.83	6.34	6.25	8.87	499.9	9.85	S.G.D.
65.22	6.00	4.10	3.42	16.25	245.1	7.76	S.G.D.
55.56	5.33	3.56	2.93	16.35	163.5	6.78	S.G.D.
65.22	4.04	7.24	7.05	16.61	406.8	9.19	S.L.D.
62.50	5.50	4.09	3.67	16.62	224.4	7.54	S.G.D.
65.22	4.83	5.48	4.92	5.48	426.2	9.34	S.G.D.
62.50	7.25	4.52	3.31	16.62	353.3	8.77	S.G.D.
55.56	3.22	5.05	5.02	10.33	174.9	6.94	S.L.D.
71.43	7.86	3.43	6.16	16.57	468.0	9.63	P.C.
60.00	6.96	3.55	1.02	--	187.8	7.11	S.G.
62.50	6.00	5.05	4.77	16.62	371.7	8.92	S.G.D.
71.43	7.71	3.66	7.39	15.86	659.1	10.80	P.C.
71.43	7.71	5.05	3.95	16.57	476.7	9.69	S.G.D.
60.00	5.40	4.06	3.83	--	206.8	7.34	S.G.
71.43	7.71	5.68	5.30	--	580.7	10.35	S.G.
78.95	5.53	9.73	8.77	--	756.5	11.34	S.L.
68.18	7.23	3.57	6.61	16.59	494.3	9.81	P.C.
60.00	4.68	5.44	5.39	--	267.1	8.01	S.L.
57.69	3.46	6.85	5.95	--	214.4	7.45	S.L.
57.69	4.50	6.85	6.80	16.33	436.7	9.41	S.L.D.
60.00	4.08	3.37	3.21	16.63	110.2	5.95	S.G.D.
78.95	7.42	3.46	5.32	7.64	530.6	10.04	P.C.
68.18	6.82	3.42	0.39	--	167.6	6.84	S.G.
62.50	6.50	3.48	1.49	9.26	174.7	6.94	S.G.D.
62.50	5.00	4.09	3.73	9.26	210.3	7.38	S.G.D.
60.00	4.68	5.91	5.91	16.63	356.7	8.80	S.L.D.
78.95	4.42	9.73	8.15	--	506.8	9.92	S.L.
48.39	4.35	4.11	4.04	16.70	171.2	6.89	S.G.D.
68.18	5.86	3.35	1.64	3.42	154.4	6.66	S.G.D.
68.18	6.82	3.35	5.00	--	267.7	8.00	PAR.
62.50	4.37	6.37	6.05	--	295.6	8.29	S.L.

55.56	4.67	4.00	3.94	--	166.9	6.83	S.G.
65.22	6.26	4.84	4.62	--	338.4	8.65	S.G.
60.00	3.72	5.91	5.81	16.31	253.9	7.86	S.L.D.
62.50	4.12	5.88	5.81	7.65	373.2	8.93	S.G.D.
68.18	5.86	5.19	4.45	5.94	433.3	9.39	S.G.D.
60.00	3.96	5.44	5.24	--	203.1	7.31	S.L.
65.22	6.13	5.48	5.27	16.61	445.9	9.48	S.G.D.
71.43	7.43	3.66	7.21	16.57	604.5	10.49	P.C.
60.00	4.20	4.99	4.99	16.63	227.9	7.58	S.L.D.
65.22	6.00	7.24	7.13	--	592.4	10.45	S.L.
68.18	8.32	3.42	6.28	16.59	513.8	9.94	P.C.
60.00	3.96	5.91	5.58	--	226.4	7.58	S.L.
71.43	6.00	6.79	6.76	16.57	644.5	10.72	S.G.D.
57.69	5.54	3.45	2.75	--	154.8	6.66	S.G.
68.18	6.14	5.19	4.78	11.18	416.3	9.26	S.G.D.
68.18	5.45	4.02	3.50	11.22	218.7	7.48	S.G.D.
68.18	6.82	3.62	1.57	16.22	197.8	7.23	S.G.D.
57.69	3.46	6.32	6.08	16.65	251.7	7.83	S.L.D.
71.43	7.71	5.05	3.77	10.71	482.8	9.73	S.G.D.
60.00	3.96	5.91	5.85	16.31	279.5	8.11	S.L.D.
71.43	6.00	5.05	4.96	--	344.7	8.70	S.G.
55.56	1.89	10.33	8.19	16.66	228.6	7.59	S.L.D.
62.50	4.00	5.88	5.67	6.37	397.3	9.12	S.G.D.
60.00	6.96	3.99	2.67	--	254.6	7.86	S.G.
55.56	5.44	3.61	2.94	16.66	171.3	6.89	S.G.D.
65.22	5.87	6.34	6.30	16.61	552.5	10.18	S.G.D.
65.22	4.17	7.24	6.56	--	320.0	8.51	S.L.
71.43	8.29	3.53	6.89	16.57	615.4	10.55	P.C.
57.69	3.46	4.58	4.57	13.14	154.4	6.66	S.L.D.
78.95	6.95	7.64	7.56	16.53	974.6	12.30	S.G.D.
62.50	6.12	5.05	4.72	16.28	381.1	8.99	S.G.D.
75.00	8.40	3.45	5.40	7.80	647.5	10.73	P.C.
65.22	5.09	4.84	4.39	6.34	320.0	8.49	S.G.D.
78.95	5.68	7.64	7.10	7.64	995.5	12.39	S.G.D.
57.69	3.46	8.10	7.60	16.65	388.5	9.05	S.L.D.
57.69	4.50	5.02	5.00	13.14	262.4	7.94	S.G.D.
62.50	4.25	6.37	6.32	16.28	353.8	8.77	S.L.D.
65.22	6.00	4.57	4.33	--	290.2	8.21	S.G.
71.43	7.14	4.59	3.81	--	353.6	8.77	S.G.
68.18	7.23	3.57	6.61	16.59	494.3	9.81	P.C.
68.18	7.91	3.42	6.12	16.59	464.4	9.61	P.C.
55.56	4.00	6.35	6.25	16.66	318.4	8.47	S.L.D.
46.87	2.44	5.46	4.97	16.45	111.8	5.98	S.L.D.
57.69	5.65	5.47	5.37	16.65	402.2	9.16	S.G.D.
68.18	5.86	5.94	5.74	11.18	517.7	9.96	S.G.D.
55.56	6.33	3.44	1.72	16.35	168.2	6.85	S.G.D.
57.69	4.73	4.58	4.51	16.65	231.6	7.62	S.G.D.
65.22	5.87	6.34	6.30	16.61	552.5	10.18	S.G.D.

48.39	4.55	4.00	3.87	16.70	172.6	6.91	S.G.D.
71.43	7.86	3.48	6.42	16.57	507.0	9.89	P.C.
65.22	6.13	4.84	4.45	16.61	350.3	8.75	S.G.D.
62.50	6.37	3.40	1.43	9.26	163.5	6.78	S.G.D.
71.43	8.29	3.59	6.60	--	566.2	10.26	PAR.
62.50	5.25	4.52	4.32	16.28	257.6	7.89	S.G.D.
75.00	7.05	3.55	0.50	5.49	188.0	7.11	S.G.D.
55.56	3.33	5.05	4.99	13.65	170.9	6.88	S.L.D.
75.00	7.20	6.37	6.06	16.55	719.5	11.12	S.G.D.
60.00	4.80	4.13	3.96	16.31	195.5	7.20	S.G.D.
83.33	11.17	3.48	6.13	9.26	1142.2	12.97	P.C.
60.00	6.72	4.06	3.06	--	257.9	7.90	S.G.
65.22	4.04	7.24	7.05	16.61	406.8	9.19	S.L.D.

3-D BED PROBE POSITION=(2CM,35CM)

SUPERFICIAL GAS VELOCITY=12.46CM/SEC PARTICLE SIZE:250-355

UB	AL	RF	RR	RW	VB	DE	SHAPE
65.22	4.83	3.49	3.23	--	137.9	6.41	S.G.
38.46	3.69	8.61	8.28	14.75	515.9	9.95	S.L.D.
75.00	6.60	3.55	1.43	5.01	186.2	7.09	S.G.D.
65.22	8.35	4.57	2.56	--	390.4	9.07	S.G.
88.24	5.29	6.72	6.57	--	436.5	9.44	S.L.
53.57	2.68	4.99	4.42	--	92.4	5.62	S.L.
45.45	2.36	7.64	7.34	10.11	271.5	8.03	S.L.D.
55.56	4.67	4.00	3.94	--	166.9	6.83	S.G.
71.43	10.43	3.53	4.76	--	371.1	8.92	PAR.
60.00	4.20	5.91	5.66	--	250.2	7.84	S.L.
57.69	4.38	4.09	4.08	--	158.7	6.72	S.G.
57.69	3.46	6.32	5.63	--	194.3	7.21	S.L.
55.56	5.44	4.12	3.73	16.66	224.6	7.54	S.G.D.
65.22	4.04	6.34	6.25	16.61	323.5	8.52	S.L.D.
57.69	5.54	4.58	3.65	4.58	320.4	8.49	S.G.D.
57.69	6.46	3.58	2.13	--	187.5	7.10	S.G.
60.00	5.28	5.44	5.39	16.31	365.1	8.87	S.G.D.
71.43	7.14	4.59	3.81	--	353.6	8.77	S.G.
60.00	5.40	4.55	4.32	16.31	270.0	8.02	S.G.D.
40.54	3.24	7.62	6.24	--	216.2	7.47	S.L.
78.95	6.95	3.32	4.83	--	254.2	7.86	PAR.
57.69	3.46	4.58	4.44	--	128.9	6.29	S.L.
68.18	4.50	6.94	6.87	16.59	444.8	9.47	S.L.D.
55.56	6.33	3.44	1.72	16.35	168.2	6.85	S.G.D.
41.67	3.33	5.37	4.97	--	148.6	6.59	S.L.
60.00	5.16	4.55	4.51	--	236.6	7.67	S.G.
83.33	7.67	3.54	5.11	7.22	646.6	10.73	P.C.
44.12	2.82	16.72	9.30	--	395.3	9.13	S.L.
83.33	5.50	4.12	3.70	16.51	227.1	7.57	S.G.D.
53.57	2.79	4.99	4.76	16.38	121.4	6.14	S.L.D.
68.18	5.45	4.02	3.58	16.22	215.2	7.43	S.G.D.
53.57	4.50	3.47	3.20	16.67	130.4	6.29	S.G.D.
57.69	3.58	6.32	6.12	16.65	265.2	7.97	S.L.D.
53.57	4.50	3.47	3.20	16.67	130.4	6.29	S.G.D.
68.18	6.82	3.35	5.00	--	267.7	8.00	PAR.
65.22	4.83	4.84	4.19	4.84	325.0	8.53	S.G.D.
100.00	10.80	3.31	6.22	16.41	654.6	10.77	P.C.
55.56	1.89	10.33	5.95	--	108.7	5.94	S.L.
46.87	4.87	4.02	3.81	16.71	189.9	7.13	S.G.D.
65.22	6.00	4.10	3.63	--	237.6	7.68	S.G.

78.95	6.47	3.46	1.70	--	171.5	6.89	S.G.
83.33	8.33	5.92	4.43	7.22	755.4	11.30	S.G.D.
88.24	9.71	3.39	4.86	--	359.4	8.82	PAR.
60.00	3.96	3.43	3.32	16.63	109.8	5.94	S.G.D.
50.00	4.10	6.80	6.68	16.69	372.5	8.93	S.L.D.
62.50	6.37	3.40	1.43	9.26	163.5	6.78	S.G.D.
65.22	6.26	4.57	4.24	--	305.2	8.35	S.G.
57.69	3.46	6.85	6.54	16.65	288.9	8.20	S.L.D.
78.95	7.42	6.33	5.13	6.33	828.6	11.65	S.G.D.
55.56	3.22	7.22	6.01	--	200.5	7.28	S.L.
75.00	5.55	3.55	2.94	--	164.8	6.80	S.G.
83.33	11.17	3.48	6.13	9.26	1142.2	12.97	P.C.
71.43	7.43	3.53	6.52	16.57	494.3	9.81	P.C.
46.87	2.34	4.88	4.50	16.19	88.1	5.52	S.L.D.
45.45	3.55	5.05	4.82	--	152.7	6.65	S.L.
78.95	6.63	3.58	1.46	4.97	190.5	7.14	S.G.D.
57.69	4.96	5.02	5.02	--	260.2	7.94	S.L.
51.72	4.86	4.00	3.90	--	176.5	6.96	S.G.
60.00	6.00	3.51	2.47	--	170.5	6.88	S.G.
71.43	6.00	6.79	6.76	16.57	644.5	10.72	S.G.D.
62.50	7.25	4.09	2.61	--	277.0	8.09	S.G.
60.00	4.92	4.99	4.45	5.44	344.8	8.70	S.G.D.
53.57	7.29	3.47	5.68	--	368.6	8.90	PAR.
62.50	6.25	4.09	3.48	--	246.8	7.78	S.G.
93.75	7.50	5.46	4.73	16.45	551.2	10.17	S.G.D.
51.72	3.62	5.85	5.41	--	191.3	7.17	S.L.
83.33	10.83	4.18	4.39	16.51	328.1	8.56	P.C.
51.72	4.24	6.78	6.69	16.40	391.6	9.08	S.L.D.
71.43	7.00	3.59	1.12	--	193.5	7.18	S.G.
60.00	6.96	3.55	1.02	--	187.8	7.11	S.G.
71.43	7.86	3.43	6.16	16.57	468.0	9.63	P.C.
88.24	6.18	4.52	3.99	16.48	309.2	8.39	S.G.D.
45.45	5.09	4.50	4.46	--	228.2	7.58	S.G.
50.00	4.50	5.05	5.04	16.69	256.5	7.88	S.G.D.
75.00	7.05	3.50	4.00	5.01	539.2	10.10	P.C.
83.33	8.00	4.02	0.63	--	273.1	8.05	S.G.
62.50	4.12	5.88	5.81	7.65	373.2	8.93	S.G.D.
40.54	3.81	14.07	13.94	14.07	2355.4	16.51	S.G.D.
78.95	5.68	3.52	2.77	--	164.7	6.80	S.G.
93.75	10.50	3.33	6.35	16.45	664.9	10.83	P.C.
71.43	7.86	3.66	7.42	16.57	676.5	10.89	P.C.
53.57	2.46	4.99	4.31	--	79.6	5.35	S.L.
46.87	4.12	4.02	4.02	--	141.7	6.47	S.G.
55.56	4.11	6.35	6.35	10.33	385.1	9.03	S.L.D.
68.18	5.86	4.98	4.22	5.94	392.9	9.09	S.G.D.
78.95	7.26	4.07	2.52	--	273.0	8.05	S.G.
45.45	2.36	5.49	4.95	16.72	106.4	5.88	S.L.D.
44.12	1.94	12.92	10.90	16.72	439.9	9.44	S.L.D.

75.00	7.05	3.50	4.00	5.01	539.2	10.10	P.C.
62.50	6.37	3.40	1.43	9.26	163.5	6.78	S.G.D.
68.18	5.86	3.35	2.07	16.59	152.2	6.62	S.G.D.
75.00	9.15	3.50	6.50	---	607.0	10.50	PAR.
88.24	9.71	3.57	7.04	---	754.7	11.30	PAR.
65.22	4.83	5.48	5.24	7.24	388.1	9.05	S.G.D.
57.69	6.69	3.54	1.38	9.98	184.0	7.06	S.G.D.
51.72	3.83	6.78	6.10	---	253.2	7.87	S.L.
75.00	6.30	3.37	1.30	5.01	158.5	6.71	S.G.D.
53.57	4.93	5.15	5.11	16.67	300.9	8.31	S.G.D.
62.50	5.25	4.02	3.67	16.28	206.7	7.34	S.G.D.
44.12	3.26	7.59	7.07	16.72	313.2	8.43	S.L.D.

3-D BED PROBE POSITION=(4CM,35CM)

SUPERFICIAL GAS VELOCITY=12.46CM/SEC PARTICLE SIZE:250-355

UB	AL	RF	RR	RW	VB	DE	SHAPE
75.00	2.55	10.24	8.87	16.55	376.8	8.96	S.L.D.
60.00	5.04	5.44	5.43	--	300.2	8.33	S.L.
53.57	2.68	4.99	4.42	--	92.4	5.62	S.L.
65.22	6.00	3.41	2.06	16.61	160.5	6.74	S.G.D.
57.69	5.42	4.02	3.77	--	204.9	7.31	S.G.
83.33	8.67	4.12	7.65	--	796.4	11.50	PAR.
65.22	6.26	4.57	4.24	--	305.2	8.35	S.G.
62.50	5.37	4.52	4.29	16.62	264.5	7.96	S.G.D.
62.50	5.00	12.16	11.90	12.16	2289.3	16.35	S.G.D.
57.69	4.38	4.09	4.08	--	158.7	6.72	S.G.
60.00	5.40	12.67	10.38	--	995.6	12.42	S.L.
53.57	2.68	4.56	4.16	--	82.7	5.42	S.L.
68.18	5.73	3.42	2.53	--	155.8	6.68	S.G.
78.95	6.32	3.37	1.65	--	158.8	6.72	S.G.
57.69	6.12	5.02	4.90	--	350.1	8.74	S.G.
55.56	4.67	4.00	3.94	--	166.9	6.83	S.G.
93.75	7.12	3.33	4.36	--	212.6	7.41	PAR.
57.69	4.27	6.32	6.30	13.14	370.5	8.91	S.L.D.
51.72	3.72	16.40	10.40	--	660.3	10.83	S.L.
68.18	5.45	3.42	2.75	--	149.8	6.59	S.G.
53.57	2.79	4.99	4.76	16.38	121.4	6.14	S.L.D.
55.56	10.67	4.12	9.66	16.35	1547.0	14.35	P.C.
60.00	5.64	6.78	6.69	--	489.9	9.81	S.L.
55.56	6.33	3.44	1.72	16.35	168.2	6.85	S.G.D.
40.54	2.76	9.51	6.70	--	205.1	7.34	S.L.
78.95	8.84	3.41	6.00	--	500.0	9.85	PAR.
53.57	2.57	4.99	4.68	16.67	106.0	5.87	S.L.D.
68.18	4.64	4.53	4.16	5.94	256.2	7.88	S.G.D.
78.95	8.68	3.37	5.32	7.64	600.3	10.47	P.C.
53.57	4.50	3.47	3.20	16.67	130.4	6.29	S.G.D.
55.56	4.89	16.66	11.79	--	1128.5	12.95	S.L.
55.56	1.89	10.33	5.95	--	108.7	5.94	S.L.
57.69	5.54	3.45	2.75	--	154.8	6.66	S.G.
57.69	3.46	6.32	5.63	--	194.3	7.21	S.L.
71.43	7.14	4.59	3.81	--	353.6	8.77	S.G.
55.56	4.56	5.50	5.42	--	259.7	7.94	S.L.
88.24	8.47	3.44	6.61	12.92	578.8	10.34	P.C.
57.69	5.65	4.09	3.78	--	221.3	7.51	S.G.
55.56	1.56	13.65	11.47	16.35	395.2	9.10	S.L.D.
57.69	6.46	3.58	2.13	--	187.5	7.10	S.G.

75.00	8.55	3.34	4.72	--	299.6	8.30	PAR.
57.69	4.85	3.42	2.97	16.65	137.0	6.40	S.G.D.
65.22	5.35	4.06	3.85	--	204.7	7.31	S.G.
71.43	3.43	16.57	10.09	--	569.8	10.31	S.L.
55.56	3.33	5.05	4.99	13.65	170.9	6.88	S.L.D.
62.50	5.50	4.09	3.67	16.62	224.4	7.54	S.G.D.
93.75	7.69	3.30	5.39	8.27	346.7	8.72	P.C.
53.57	4.18	14.16	13.94	16.67	1893.8	15.35	S.L.D.
55.56	1.67	13.65	11.66	16.35	441.9	9.45	S.L.D.
88.24	9.71	3.44	6.42	--	628.9	10.63	PAR.
60.00	5.28	4.13	3.96	--	207.2	7.34	S.G.
51.72	4.86	4.00	3.90	--	176.5	6.96	S.G.
65.22	5.48	3.41	2.71	--	149.4	6.58	S.G.
57.69	3.58	5.47	5.38	16.65	209.1	7.36	S.L.D.
88.24	5.82	3.44	2.48	--	159.7	6.73	S.G.
53.57	2.46	4.56	4.30	16.67	85.9	5.47	S.L.D.
57.69	3.46	4.58	4.44	--	128.9	6.29	S.L.
51.72	4.76	4.52	4.51	--	208.8	7.36	S.G.
75.00	7.50	3.55	7.03	16.55	580.7	10.35	P.C.
62.50	5.50	4.09	3.67	16.62	224.4	7.54	S.G.D.
68.18	9.68	3.38	4.10	5.19	775.5	11.40	P.C.
55.56	6.33	3.44	1.72	16.35	168.2	6.85	S.G.D.
55.56	6.56	5.50	5.40	--	447.9	9.49	S.G.
57.69	4.38	13.14	9.80	--	705.2	11.07	S.L.
50.00	4.30	6.80	6.33	--	312.0	8.44	S.L.
48.39	3.77	6.20	6.07	16.70	279.5	8.11	S.L.D.
62.50	7.50	3.48	5.81	--	397.6	9.12	PAR.
83.33	9.67	4.02	7.62	--	880.7	11.89	PAR.
55.56	4.89	4.06	3.97	--	182.1	7.03	S.G.
60.00	4.20	4.55	4.54	16.63	194.9	7.19	S.G.D.
60.00	5.28	4.13	3.96	--	207.2	7.34	S.G.
55.56	5.00	5.05	5.00	16.66	296.2	8.27	S.G.D.
48.39	3.87	5.89	5.53	--	216.3	7.47	S.L.
65.22	4.04	6.34	6.25	16.61	323.5	8.52	S.L.D.
60.00	4.92	4.13	4.05	--	189.1	7.12	S.G.
55.56	4.56	5.50	5.50	16.66	302.9	8.33	S.L.D.
65.22	4.04	6.34	6.25	16.61	323.5	8.52	S.L.D.
57.69	4.50	6.85	6.80	16.33	436.7	9.41	S.L.D.
62.50	7.25	4.09	2.61	--	277.0	8.09	S.G.
48.39	4.35	8.09	7.90	16.70	556.6	10.21	S.L.D.
51.72	3.41	6.78	6.47	16.40	278.7	8.10	S.L.D.
88.24	8.12	3.44	5.87	--	439.9	9.44	PAR.
60.00	5.04	7.80	7.75	16.63	648.6	10.74	S.L.D.
53.57	6.21	3.35	1.75	--	155.4	6.67	S.G.
75.00	5.70	5.01	4.81	16.55	345.0	8.70	S.G.D.
60.00	3.72	6.78	6.68	12.67	350.6	8.75	S.L.D.
51.72	4.03	4.11	4.11	--	141.5	6.48	S.L.
62.50	6.00	6.37	6.36	--	494.8	9.84	S.L.

65.22	6.26	4.57	4.24	--	305.2	8.35	S.G.
71.43	7.14	4.59	3.81	--	353.6	8.77	S.G.
51.72	3.00	5.85	5.71	11.09	202.2	7.28	S.L.D.
83.33	8.50	7.22	6.70	16.51	1108.6	12.84	S.G.D.
55.56	5.00	3.61	3.33	--	152.7	6.63	S.G.
55.56	5.00	7.22	6.87	--	436.2	9.44	S.L.
65.22	4.04	6.34	6.25	16.61	323.5	8.52	S.L.D.
62.50	4.75	4.56	4.49	16.62	231.5	7.62	S.G.D.
60.00	7.32	5.44	5.11	--	505.3	9.88	S.G.
55.56	5.11	8.51	8.44	16.66	778.6	11.41	S.L.D.
71.43	6.29	3.59	2.19	16.57	186.9	7.09	S.G.D.
78.95	6.16	3.37	1.90	--	157.2	6.70	S.G.

3-D BED PROBE POSITION=(6CM,35CM)

SUPERFICIAL GAS VELOCITY=12.46CM/SEC PARTICLE SIZE:250-355

UB	AL	RF	RR	RW	VB	DE	SHAPE
46.87	3.75	4.08	4.06	--	124.9	6.22	S.L.
53.57	2.68	4.99	4.42	--	92.4	5.62	S.L.
62.50	4.25	9.26	8.94	16.62	693.2	10.98	S.L.D.
60.00	6.72	3.51	1.41	--	179.8	7.00	S.G.
55.56	4.67	4.00	3.94	--	166.9	6.83	S.G.
51.72	4.66	4.11	3.98	16.68	186.9	7.09	S.G.D.
115.38	7.15	4.09	2.48	16.33	276.2	8.08	S.G.D.
65.22	4.83	5.48	5.24	7.24	388.1	9.05	S.G.D.
83.33	8.67	4.12	7.65	--	796.4	11.50	PAR.
75.00	7.35	3.32	4.95	--	282.9	8.14	PAR.
53.57	2.57	4.99	4.68	16.67	106.0	5.87	S.L.D.
60.00	5.28	5.44	5.39	16.63	364.2	8.86	S.G.D.
62.50	4.37	5.88	5.69	--	266.0	8.00	S.L.
60.00	4.56	4.55	4.35	7.80	240.8	7.72	S.G.D.
57.69	4.38	4.09	4.08	--	158.7	6.72	S.G.
65.22	4.04	6.34	6.25	16.61	323.5	8.52	S.L.D.
71.43	7.14	4.59	3.81	--	353.6	8.77	S.G.
75.00	6.75	3.37	5.03	--	268.4	8.00	PAR.
65.22	3.52	3.60	3.60	--	94.5	5.67	S.L.
93.75	7.87	3.36	6.32	8.27	480.4	9.72	P.C.
60.00	5.04	7.80	7.75	16.63	648.6	10.74	S.L.D.
62.50	6.00	6.37	6.36	--	494.8	9.84	S.L.
65.22	6.26	4.57	4.24	--	305.2	8.35	S.G.
68.18	4.77	4.53	4.45	16.59	229.9	7.60	S.G.D.
60.00	2.88	6.78	6.22	16.63	210.1	7.38	S.L.D.
57.69	3.46	4.58	4.44	--	128.9	6.29	S.L.
88.24	5.29	3.32	2.52	16.48	139.4	6.43	S.G.D.
60.00	5.28	5.44	5.39	16.31	365.1	8.87	S.G.D.
57.69	5.19	3.49	3.05	--	149.2	6.58	S.G.
65.22	4.83	4.84	4.19	4.84	325.0	8.53	S.G.D.
68.18	7.23	3.57	6.61	16.59	494.3	9.81	P.C.
68.18	7.36	3.57	4.10	5.19	642.5	10.71	P.C.
75.00	9.15	3.34	3.25	3.50	672.4	10.87	P.C.
83.33	14.33	3.42	7.72	--	1340.5	13.68	PAR.
78.95	5.37	9.73	8.70	--	718.6	11.14	S.L.
55.56	6.33	3.44	1.72	16.35	168.2	6.85	S.G.D.
71.43	3.43	16.57	10.09	--	569.8	10.31	S.L.
55.56	1.89	10.33	5.95	--	108.7	5.94	S.L.
83.33	6.17	3.38	1.91	--	158.3	6.71	S.G.
71.43	8.29	3.59	6.60	--	566.2	10.26	PAR.

88.24	12.71	3.44	7.35	--	1077.8	12.72	PAR.
83.33	6.83	3.35	4.96	--	264.1	7.96	PAR.
55.56	3.22	7.22	6.01	--	200.5	7.28	S.L.
53.57	4.93	6.37	6.37	16.67	437.8	9.42	S.L.D.
71.43	6.43	3.48	1.84	--	173.4	6.92	S.G.
65.22	6.00	4.10	3.63	--	237.6	7.68	S.G.
62.50	4.12	6.37	6.37	9.26	409.2	9.21	S.G.D.
60.00	5.28	4.13	3.96	--	207.2	7.34	S.G.
68.18	8.32	3.42	6.28	16.59	513.8	9.94	P.C.
55.56	1.67	13.65	11.66	16.35	441.9	9.45	S.L.D.
60.00	5.04	4.13	4.02	--	195.2	7.20	S.G.
51.72	3.21	6.78	6.76	8.96	345.1	8.70	S.L.D.
75.00	10.50	3.45	6.71	--	742.2	11.23	PAR.
48.39	4.55	4.00	3.87	16.70	172.6	6.91	S.G.D.
48.39	4.35	4.11	4.04	16.70	171.2	6.89	S.G.D.
51.72	4.45	6.78	6.72	16.40	420.8	9.30	S.L.D.
53.57	4.71	4.56	4.50	16.38	229.4	7.59	S.G.D.
50.00	4.30	6.80	6.33	--	312.0	8.44	S.L.
46.87	2.44	4.88	4.53	16.45	93.8	5.64	S.L.D.
71.43	5.86	4.59	4.41	--	283.9	8.15	S.G.
60.00	7.32	5.44	5.11	--	505.3	9.88	S.G.
53.57	4.07	16.38	16.25	16.38	3412.4	18.68	S.G.D.
71.43	7.86	3.43	6.16	16.57	468.0	9.63	P.C.
55.56	3.33	5.05	4.99	13.65	170.9	6.88	S.L.D.
68.18	6.82	3.35	5.00	--	267.7	8.00	PAR.
78.95	8.05	6.33	6.10	--	743.7	11.24	S.G.
71.43	6.29	3.59	2.19	16.57	186.9	7.09	S.G.D.
62.50	5.50	3.63	2.88	12.16	176.0	6.95	S.G.D.
93.75	7.87	3.33	5.20	--	334.0	8.61	PAR.
65.22	7.17	5.48	5.21	--	499.7	9.85	S.G.
65.22	5.35	3.49	2.80	16.61	157.0	6.69	S.G.D.
93.75	7.87	3.30	3.78	4.56	411.0	9.22	P.C.
75.00	9.45	3.40	6.15	--	561.1	10.23	PAR.
83.33	11.17	3.48	6.13	9.26	1142.2	12.97	P.C.
71.43	8.29	3.59	6.60	--	566.2	10.26	PAR.
53.57	2.79	4.15	3.92	--	78.4	5.33	S.L.
62.50	4.75	4.56	4.49	16.62	231.5	7.62	S.G.D.
51.72	3.00	5.85	5.71	11.09	202.2	7.28	S.L.D.
41.67	4.50	4.98	4.96	--	221.6	7.53	S.L.
68.18	5.86	4.98	4.49	8.53	374.7	8.94	S.G.D.
60.00	3.72	6.78	6.68	12.67	350.6	8.75	S.L.D.
55.56	5.11	8.51	8.44	16.66	778.6	11.41	S.L.D.
55.56	5.00	7.22	6.87	--	436.2	9.44	S.L.
78.95	9.16	3.65	4.32	--	268.2	8.00	PAR.
65.22	6.26	4.57	4.24	--	305.2	8.35	S.G.
57.69	5.54	3.45	2.75	--	154.8	6.66	S.G.
57.69	4.73	4.50	4.33	9.98	237.1	7.68	S.G.D.
50.00	7.70	3.39	6.31	9.26	474.1	9.67	P.C.

44.12	3.53	6.07	5.89	16.72	242.6	7.74	S.L.D.
68.18	6.00	3.30	1.77	16.59	148.0	6.56	S.G.D.
46.87	4.69	5.91	5.91	16.71	356.9	8.80	S.L.D.
60.00	4.20	4.55	4.54	16.63	194.9	7.19	S.G.D.
62.50	5.00	4.09	3.86	16.28	202.3	7.28	S.G.D.
44.12	3.88	5.54	5.29	--	201.3	7.29	S.L.
55.56	4.67	4.00	3.94	--	166.9	6.83	S.G.
40.54	6.49	3.34	0.94	6.77	156.2	6.68	S.G.D.
57.69	5.54	4.09	3.64	16.33	225.5	7.55	S.G.D.
57.69	10.85	3.94	4.56	16.65	354.8	8.78	P.C.
62.50	4.37	5.88	5.69	--	266.0	8.00	S.L.
65.22	6.13	3.45	2.01	16.61	166.9	6.83	S.G.D.

3-D BED PROBE POSITION=(8CM,35CM)

SUPERFICIAL GAS VELOCITY=12.46CM/SEC PARTICLE SIZE:250-355

UB	AL	RF	RR	RW	VB	DE	SHAPE
68.18	5.45	4.02	3.58	16.22	215.2	7.43	S.G.D.
46.87	2.44	4.88	4.53	16.45	93.8	5.64	S.L.D.
62.50	6.50	3.48	1.49	9.26	174.7	6.94	S.G.D.
60.00	5.40	5.44	5.37	16.63	375.1	8.95	S.G.D.
83.33	8.33	7.22	6.75	16.51	1084.9	12.75	S.G.D.
55.56	3.22	7.22	6.01	--	200.5	7.28	S.L.
51.72	4.86	4.00	3.78	16.68	186.9	7.09	S.G.D.
60.00	4.20	3.37	3.26	--	108.9	5.93	S.G.
55.56	4.00	6.35	6.25	16.66	318.4	8.47	S.L.D.
78.95	10.26	3.58	7.29	--	857.4	11.79	PAR.
60.00	3.84	5.44	5.40	16.31	231.9	7.62	S.L.D.
68.18	6.82	3.38	5.49	16.22	322.9	8.51	P.C.
68.18	9.14	3.38	6.35	16.59	578.5	10.34	P.C.
57.69	3.58	6.85	6.58	16.65	304.5	8.35	S.L.D.
62.50	4.00	5.88	5.53	5.88	418.0	9.28	S.G.D.
71.43	6.00	6.79	6.75	15.86	649.3	10.74	S.G.D.
65.22	6.26	4.84	4.39	16.61	358.3	8.81	S.G.D.
53.57	2.79	4.99	4.76	16.38	121.4	6.14	S.L.D.
60.00	5.28	4.13	3.96	--	207.2	7.34	S.G.
53.57	4.50	3.50	3.25	16.38	133.3	6.34	S.G.D.
62.50	6.00	5.05	4.77	16.28	372.2	8.92	S.G.D.
55.56	6.33	3.48	1.80	13.65	173.1	6.91	S.G.D.
71.43	7.57	5.05	4.03	15.86	470.2	9.65	S.G.D.
65.22	5.87	6.34	6.32	--	474.6	9.70	S.L.
55.56	4.67	4.06	3.91	16.66	182.8	7.04	S.G.D.
53.57	4.50	3.50	3.25	16.67	133.2	6.34	S.G.D.
60.00	4.80	4.55	4.46	16.31	233.6	7.64	S.G.D.
83.33	14.33	3.42	7.72	--	1340.5	13.68	PAR.
65.22	4.04	6.34	6.25	16.61	323.5	8.52	S.L.D.
60.00	4.08	5.91	5.62	--	238.2	7.71	S.L.
53.57	2.57	4.99	4.68	16.67	106.0	5.87	S.L.D.
65.22	3.91	7.24	7.03	16.25	389.3	9.06	S.L.D.
78.95	4.11	9.73	9.33	16.53	728.4	11.16	S.L.D.
75.00	10.50	3.50	6.96	--	799.3	11.51	PAR.
60.00	6.84	3.61	1.45	16.31	195.1	7.20	S.G.D.
62.50	7.25	4.52	3.59	--	346.5	8.71	S.G.
75.00	7.50	4.02	1.83	15.14	270.2	8.02	S.G.D.
57.69	4.50	6.85	6.80	16.33	436.7	9.41	S.L.D.
55.56	4.44	4.06	3.96	16.66	171.9	6.90	S.G.D.
60.00	5.04	4.13	3.89	16.31	207.2	7.34	S.G.D.

65.22	4.83	5.48	4.92	5.48	426.2	9.34	S.G.D.
57.69	3.46	5.02	4.77	--	145.5	6.54	S.L.
60.00	5.04	4.55	4.41	16.31	248.4	7.80	S.G.D.
55.56	3.33	5.50	5.40	13.65	198.0	7.23	S.L.D.
62.50	4.37	6.37	6.33	16.62	367.8	8.89	S.L.D.
57.69	4.38	4.09	4.08	--	158.7	6.72	S.G.
68.18	5.86	4.98	4.22	5.94	392.9	9.09	S.G.D.
60.00	4.20	4.55	4.54	16.63	194.9	7.19	S.G.D.
65.22	6.13	5.48	5.27	16.61	445.9	9.48	S.G.D.
55.56	1.78	10.33	8.04	16.66	205.6	7.32	S.L.D.
78.95	6.16	3.37	1.40	3.65	158.8	6.72	S.G.D.
65.22	5.35	4.10	3.91	--	208.3	7.35	S.G.
53.57	2.57	4.99	4.68	16.67	106.0	5.87	S.L.D.
57.69	3.46	6.32	6.08	16.65	251.7	7.83	S.L.D.
78.95	5.68	7.64	7.64	14.37	772.3	11.38	S.G.D.
57.69	6.46	4.02	3.20	--	245.4	7.77	S.G.
68.18	6.82	3.38	5.49	16.59	321.9	8.50	P.C.
51.72	2.79	5.02	4.78	16.68	122.5	6.16	S.L.D.
60.00	5.04	4.13	3.89	16.31	207.2	7.34	S.G.D.
57.69	7.27	4.09	2.57	--	276.5	8.08	S.G.
75.00	7.35	6.37	6.02	16.55	736.7	11.21	S.G.D.
60.00	6.96	3.99	2.67	--	254.6	7.86	S.G.
55.56	5.33	3.61	3.01	16.66	168.2	6.85	S.G.D.
68.18	5.59	6.94	6.68	8.53	733.0	11.19	S.G.D.
57.69	3.46	6.85	6.54	16.65	288.9	8.20	S.L.D.
60.00	4.92	4.99	4.99	--	254.5	7.88	S.L.
71.43	3.43	16.57	16.48	16.57	2947.4	17.79	S.G.D.
62.50	4.25	6.37	6.31	16.62	352.1	8.76	S.L.D.
48.39	4.55	4.00	3.87	16.70	172.6	6.91	S.G.D.
65.22	6.26	4.84	4.62	--	338.4	8.65	S.G.
55.56	4.78	3.61	3.04	6.35	159.0	6.72	S.G.D.
78.95	4.42	9.73	8.15	--	506.8	9.92	S.L.
55.56	3.33	5.05	4.99	13.65	170.9	6.88	S.L.D.
62.50	5.50	5.88	5.84	16.62	442.2	9.45	S.G.D.
65.22	7.70	3.60	6.39	--	493.8	9.81	PAR.
53.57	4.50	3.50	3.25	16.67	133.2	6.34	S.G.D.
60.00	5.40	4.06	3.83	--.	206.8	7.34	S.G.
68.18	7.23	3.57	6.61	16.59	494.3	9.81	P.C.
78.95	7.42	6.33	5.13	6.33	828.6	11.65	S.G.D.
55.56	5.00	5.05	5.00	16.66	296.2	8.27	S.G.D.
53.57	2.68	4.56	4.37	16.67	98.6	5.73	S.L.D.
68.18	6.82	3.35	5.00	--	267.7	8.00	PAR.
71.43	7.57	6.79	6.74	--	768.1	11.36	S.G.
60.00	4.20	4.55	4.54	16.63	194.9	7.19	S.G.D.
65.22	6.26	4.57	4.24	--	305.2	8.35	S.G.
55.56	1.89	10.33	5.95	--	108.7	5.94	S.L.
60.00	4.92	4.55	4.44	16.63	240.7	7.72	S.G.D.
62.50	4.12	5.88	5.81	7.65	373.2	8.93	S.G.D.

71.43	7.57	3.59	6.90	16.57	565.0	10.26	P.C.
65.22	4.04	6.34	6.25	16.61	323.5	8.52	S.L.D.
55.56	3.33	5.50	5.47	10.33	216.3	7.45	S.L.D.
53.57	4.29	3.55	3.47	--	122.2	6.16	S.G.
60.00	5.40	4.06	3.66	16.31	216.4	7.45	S.G.D.
62.50	6.25	3.44	1.68	7.65	167.3	6.84	S.G.D.
68.18	8.32	3.42	6.28	16.59	513.8	9.94	P.C.
71.43	7.86	3.43	6.16	16.57	468.0	9.63	P.C.
55.56	5.33	3.61	3.01	16.66	168.2	6.85	S.G.D.
60.00	5.16	4.55	4.51	--	236.6	7.67	S.G.
65.22	4.83	5.48	5.24	7.24	388.1	9.05	S.G.D.
53.57	2.68	4.99	4.42	--	92.4	5.62	S.L.